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THIRTY-FOURTH ANNUAL
DATE GROWERS' INSTITUTE

HELD IN

COACHELLA VALLEY

APRIL 27, 1957

VOLUME 34

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EFFECT OF IRRIGATION AND LEAF-BUNCH RATIO ON SHRIVEL AND RAIN DAMAGE OF THE MAKTOOM DATE

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INTRODUCTION

The Maktoom variety has been particularly subject to an injury not common in many other varieties. A type of shrivel occurs just before the fruit begins to ripen. The tip shrivels first and the shrivel may spread over the entire fruit. In extreme cases the fruit fails to ripen. In all cases it fails to ripen into the plump firm soft No. 1 date required for sale at premium prices.

During 1949 and 1950 an experiment (7) was conducted with the Maktoom variety in the Salt River Valley to study the effect of irrigation programs, thinning and bunch protection as a means of reducing rain damage to date fruit and to observe the effects of such treatments on shrivel. This preliminary experiment, which was terminated after 2 years, showed that by allowing the soil moisture to be reduced to the point where the rate of elongation of the spike leaf on the palm was restricted by 10 to 40 per cent between July and September the amount of checking, tearing and fermentation, which is directly related to rain injury, was not only reduced but also a marked reduction in shrivel took place.

This report presents data from a second experiment to further study the problem of shrivel and rain injury on Maktoom fruit grown on palms subjected to two different soil moisture conditions and leaf bunch ratios.

METHODS AND MATERIALS

A cooperative experiment was initiated in 1951 at the Greer date garden at 1140 West Myrtle Avenue north of Phoenix.

The deep rather uniform soil in this garden is classified as Cajon loam. The palms, which were about 18 years old, had been almost completely defoliated by the severe freeze of January 1950, and did not carry the full complement of normal uninjured leaves until 1953. The irrigation treatments were applied to large plots containing 24 palms, each plot was three rows wide and eight trees long. All data was obtained from the five palms in the center of each plot. Two replications of the treatments were made. The treatments were as follows: A: moderate irrigation throughout the year with 10-12 irrigations per year. B: moderate irrigation during the winter the same as A but with infrequent irrigations during the summer and fall so that the rate of leaf elongation was retarded during July, August and September.

Because of the reduced leaf area two leaf-bunch ratios were provided. Two trees in each plot were allowed to carry only three bunches in 1951 and 1952 and four bunches in 1953 and 1954. The remaining three trees carried six or seven bunches in 1951 and 1952 and eight bunches in 1953 and 1954. In all years the fruit set was irregular with only three to five well pollinated bunches per tree. When removing the bunches from the high leaf-buneh ratio palms, bunches with the poor fruit set were removed so that the total fruit reduction was not in proportion to the bunch reduction.

Blossoming dates tended to be late each year so that blossoms were pollinated during the latter half of April or early May. Four to six pickings were made each year. The dates ripened during the following periods: 1951, October 5 to November 27; 1952, October 24 to December 2; 1953, October 21 to December 23; 1954, October 21 to December 3. Either the entire crop or samples from each picking on each tree were graded either at the garden or in the laboratory. Commercial No. 1 and No. 2 fruit were selected. In 1953 and 1954 damaged fruit was graded into classes according to the type of injury which occurred each year.

In 1954 a disorder occurred in which the fruit retained a high moisture content as it ripened. This unnatural ripening produced a soft mushy fruit which fermented readily during maturation and dehydration. This disorder appeared to be physiological although an unknown fungus or bacteria may be involved.

Irrigations were applied to the Dry treatment (B) in a manner calculated to reduce the rate of growth of the terminal leaf from 15 to 20 per cent during July and August. Two or three heavy irrigations of about 8 acre inches were applied during January and February each year. Subsequent irrigations of about six acre inches were applied on the dates shown in Table 1. No irrigations were applied to either plot during the harvest period. Precipitation during the summer months at a private meteorological station about ¾ mile from the date garden is included with the irrigation dates in Table 1.

The effect of irrigation upon the rate of leaf elongation was obtained at weekly intervals by measuring the growth of the spike leaf by means of a steel tape attached to it with a long wire (1).

Table 1—Dates of Irrigation and Precipitation

	1951			1952			1953			1954		
	Irrig. Date	Precip.† Date	Amt. (inches)	Irrig. Date	Precip.† Date	Amt. (inches)	Irrig. Date	Precip.† Date	Amt. (inches)	Irrig. Date	Precip.† Date	Amt. (inches)
March	18*			24*			29*					
April	18			10			21			6* 25*		
May	1* 22	15	.38	18*	Total	0	9* 31	15	.35	13	20	.15
June	10 29	Total	0	9 26	Total	0	15	Total	0	5	Total	.08
July	8* 19	18 27	.23 .82	10	28	1.26	21*	16 18 30	1.15 .23 .93	1 8 29*	12 20	.29 .18
Aug.		1 3 27 28 29	1.39 .53 2.02 .79 .93	2*	15 24 27	.21 .86 .50	10 28	24 27 28	.24 .48 .37	20	3 5 10	.24 1.16 .16
Sept.		29	.32		21	.18	11	Total	0	20‡	22	.53

†Precipitation is reported only on dates when more than .14" occurred.
‡Dry guard rows irrigated by mistake.
*Dates both wet and dry plots were irrigated. On all other dates only the wet plots were irrigated. About six acre inches of water was applied at each irrigation. Both wet and dry plots were irrigated two or three times between December and February each year.

RESULTS

Rate of Leaf Elongation

Data on leaf elongation for the summer months, which is summarized in Table 2, shows that in 1951 and 1952 the irrigation program provided in the Dry treatment was sufficient to maintain normal growth during June and July and caused a moderate significant reduction in August. Apparently, the soil occupied by the roots was not completely refilled with water in the winter of 1953 because a significant reduction in growth rates in the Dry treatment occurred in all months between June and October. The maximum reduction occurred in August when the growth was only 73% of the wet plot. In 1954, significant but lesser amounts of growth restriction occurred during July, August and September. No soil samples were taken, but the changes in the resistance of gypsum blocks buried in the soil indicated that the soil moisture was maintained above the wilting point at the 18 inch depth for from 15-18 days after each irrigation during the summer months.

Irrigations applied to the dry plots in the summer usually did not thoroughly wet the fourth foot and a gradual reduction in soil moisture at this depth and below occurred as the summer progressed.

Fruit Yield and Quality

Data pertaining to yields, grades, and type of injury to the fruit are set forth in Table 3. The production of fruit was generally low throughout the experimental period. This was partly caused by the reduction in crop by bunch removal on 40 per cent of the key palms. Also, the palms which carried 7 or 8 bunches never carried a full crop because of the poor pollination.

The wet plot palms produced a slightly greater yield which was not statistically different than that of the dry plot palms. However, a real reduction in yield is suggested, because the dry treatment caused an approximate 15 per cent reduction in size of the fruit which was significantly different.

The percentage of the crop which was of commercial value and the percentage of No. 1 fruit show that low soil moisture during periods of rainfall increased the amount of marketable fruit. In 1951 when 3.74 inches of rain fell almost continuously during a 67 hour period, an 87 per cent loss of fruit occurred in the wet plots. The loss was 83 per cent in the dry plots. Although less fruit was damaged, the total loss was so great that the gain was not of commercial importance. In 1952, neither the wet nor the dry plots were irrigated after August 2. The very low losses following the relatively heavy precipitation on August 24 and 27 suggest that the soil was sufficiently dry to reduce the damage in both plots so that a high percentage of the crop was harvested and no significant differences between irrigation treatments occurred.

Table 2—Rate of Spike Leaf Elongation in Centimeters Per Day

	1951		1952		1953		1954	
	Wet	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**
June (Ave. Rate)	3.2	3.1	3.0	2.9	2.7	2.5*	2.9	2.8
% of wet		99		95		92		98
July (Ave. Rate)	3.8	3.6	3.0	2.9	3.6	3.1*	3.4	2.8*
% of wet		94		95		84		83
Aug. (Ave. Rate)	3.8	3.5*	3.3	2.7*	3.6	2.7*	3.7	3.3*
% of wet		92		82		75		89
Sept. (Ave. Rate)	4.0	3.9	4.2	3.6*	3.7	2.9*	3.7	3.3*
% of wet		98		86		78		89
Oct. (Ave. Rate)	3.3	3.2	....	....	2.7	2.4*	3.0	2.7*
%of wet		97				89		90

*Rate of elongation of the spike leaves on dry palms is significantly less than the rate on wet palms.

Table 3—Effect of Irrigation on Total Yield, Grades, Type of Injury and Fruit Size

		1951	1952	1953	1954
Total yield	Wet	125	118	114	158
in lbs./palm	Dry	114	97	102	153
Per cent Total	Wet	10	92	45	34
Commercial	Dry	13	90	75*	32
Per cent	Wet			15	19
Grade 1	Dry			50†	13
Per cent	Wet			7	3
Checked	Dry			.3†	1
Per cent	Wet			33	27
Shrivel (a)	Dry			12†	22
Per cent	Wet			6	53
Mushy	Dry			4	57
Ave. weight	Wet			18.4	17.5
Per fruit (grams)	Dry			15.4*	15.5*

*Significant difference.
†Highly significant difference

In 1953 the irrigation on August 28 coincided with a rainfall period. Under these conditions the dry plot palms produced a highly significant increase in the total commercial and No. 1 grade fruit. Seventy-five per cent of the fruit from the dry plot palms was graded commercial and 50 per cent of the total crop graded number 1. Whereas, in the wet plots only 45 per cent could be packed and only 15 per cent of the total was of Grade 1. Although this infrequent irrigation program greatly reduced the losses from checking, the greatest improvement occurred through the reduction in the amount of pre-ripening shrivel. These results were in agreement with the information obtained from the first experiment in 1949 (7).

In 1954 only one severe rainstorm occurred on August 5. The fruit was green at this period and no evident damage was inflicted. In this year a peculiar softness of the fruit developed during ripening. The fruit apparently failed to lose moisture in a normal manner during ripening so that the pulp became very soft, wet, and mushy. The fruit could not be dehydrated and cured artificially in a satisfactory manner and all such fruit was lost. Over 50 per cent of the fruit from both the wet and dry palms was affected. Therefore, treatments did not produce any improvement in the amount of commercial packable fruit in this year.

Effect on Palm Growth and Bunch Production

The irrigation treatments failed to produce significant differences in the number of leaves which developed in any year, but significantly decreased the growth of the trunk in 1953 and 1954 (Table 4). This effect suggests that the rate of growth of the trunk or meristele of the palm is not necessarily directly related to the production of new leaves. Because the reduction in growth becomes greater each successive year it appears that the effects of low soil moisture are accumulative with respect to cell enlargement. Data previously presented by the senior author (4) on the mode of growth of the palm stem would indicate that a stable condition which represents the true growth rate of these palms should occur in the third or fourth year after the initiation of a moisture stress program.

The inflorescence development for each year is also indicated in Table 4. The number of inflorescences produced in each year refers to the number which emerged and were pollinated the following spring. Thus, the inflorescences recorded for 1951 refer to those which emerged in April and May in 1952. It is clearly evident that the irrigation treatments

had no effect on the initiation of floral parts.

Effects of Different Leaf-Bunch Ratios and Fruit Set

The results of establishing different leaf bunch ratios are set forth in Table 5. By the removal of bunches down to 3 or 4 per palm a leaf-bunch ratio of 22-26: 1 was produced. These were compared with ones which carried 7 or 8 bunches per palm that had a 10-12: 1 leaf-bunch ratio. The palms which carried 7 or 8 bunches in 1951 produced slightly fewer inflorescences in 1952 which suggests a slight deficit in the carbohydrate supply in 1952. The number of inflorescences increased, however, in both 1953 and 1954 which indicates that the carbohydrate supply was ample in these years.

The larger number of inflorescences produced in each successive year by the palms carrying only 3 or 4 bunches suggests that ample supplies of carbohydrates were always available during the fruit ripening period. Since there are neither consistent differences in the percentage of commercial fruit nor in the percentage of fruit shrivel with respect to the different leaf-bunch ratios, it appears that the pre-ripening shrivel problem is not related to the carbohydrate supply from the leaves.

In 1953, the year when the largest amount of shrivel occurred, the 7 bunch palms had the highest percentage of shrivel. In this year, all the fruit from all of the pickings was graded and each bunch was graded individually. The set of fruit was highly variable ranging from 2 to 30 pounds per palm on the seven bunch palms. These variations were obtained without removal of any strands or fruit and a large number of unpollinated fruits remained on each bunch. This presented a unique situation whereby the effect of thinning could be evaluated without the introduction of artificial conditions. Thus, the possibility that strand removal and thinning might induce changes in the distribution of nutrients was eliminated. Also, because of the prevalence of unpollinated fruit the actual volume of the bunch was large so that differences in aeration of the fruit was minimized.

The relationship between the number of pollinated fruit on the bunch as indicated by the weight of the bunch and the percentage of the fruit which shrivelled is shown in Figure 1. A highly significant regression coefficient was obtained. As the number of fruit on the bunch increased the percentage of fruit affected with shrivel decreased. This situation which is in agreement with data from regular planned thinning experiments (5, 6), also tends to minimize the possibility that carbohydrate supply is a factor affecting shrivel.

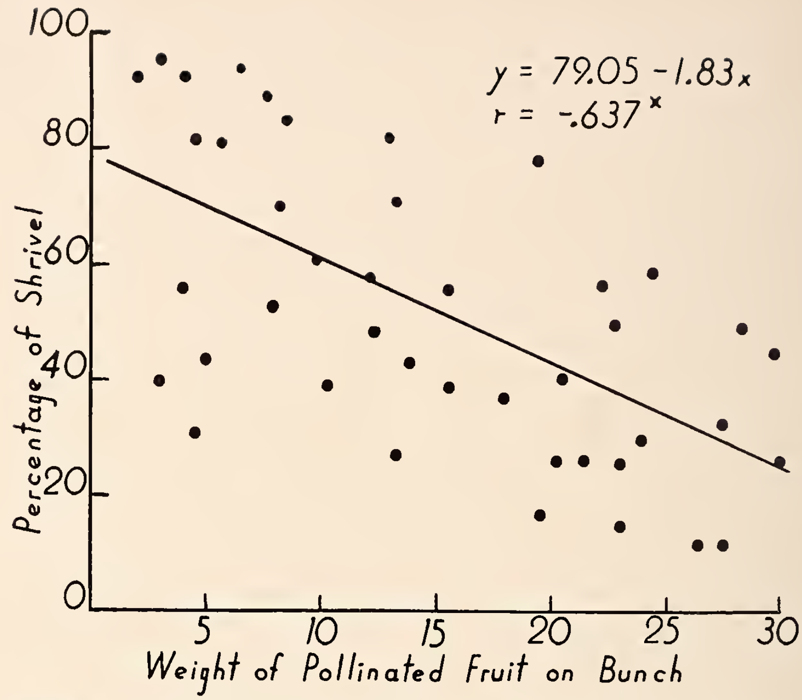

Figure 1: *Effect of number of fruit on the bunch as reflected by bunch weight on percentage of fruit which developed shrivel.*

Table 4—Effect of Irrigation on Palm Growth, Leaf and Inflorescence Production

		1951	1952	1953	1954	Ave.
Palm trunk growth	Wet		9.8	6.7	10.4	9.0
(inches/year)	Dry		8.6	4.8*	6.8*	6.7
Leaf Production	Wet	23.0	23.0	21.2	21.4	22.1
(leaves/year)	Dry	22.3	22.3	22.0	20.0	21.7
Inflorescence Production	Wet	9.0	10.2	11.4	12.2	10.7
(inflorescences/year)	Dry	9.2	9.2	9.9	12.9	10.3

*Growth of dry plot palms is significantly less than wet plot palms.

Table 5—Effect of Changing Leaf-Bunch Ratios on Inflorescence Production, Percent Commercial Yields and Shrivel of Fruit

	No. bunches per palm	1951	1952	1953	1954
Leaf bunch	7 or 8	12:1	11:1	12:1	11:1
Ratio	3 or 4	26:1	25:1	22:1	22:1
No Inflor.	7 or 8	9.4	8.2	10.2	11.3
Produced	3 or 4	8.9	11.9*	11.4	14.4*
% of Fruit	7 or 8 Wet	13	92	41	32
Commercial	3 or 4 Wet	8	93	57	37
	7 or 8 Dry	18	90	73†	26
	3 or 4 Dry	9	89	81†	39
% Shrivel	7 or 8 Wet	....	....	35	25
	3 or 4 Wet	....	....	31	30
	7 or 8 Dry	—	—	14†	20
	3 or 4 Dry	....	....	10†	25

*Differences between bunches produced are significant.
†Differences between wet and dry are highly significant but not significant between number of bunches per palm.

DISCUSSION

The information presented herein together with the data from the first experiment published in 1951 (7) show clearly that checking and shrivel on Maktoom dates have been significantly reduced in commercially important quantities when palms are growing under reduced soil moisture at the time rains occur. The reduction in checking and blacknose is apparently induced directly by the internal water deficit in the palm which allows the fruit to adjust to the increased internal water supply produced by the reduction in transpiration during rains without rupturing the epidermal layer of the fruit. This follows from the fundamental studies of Aldrich, Furr, et. al. in 1946 (2) which showed that checking was induced by increased internal water pressures when the fruit is exposed to high humidity conditions.

In the absence of a fundamental study of the factors associated with shrivel the reason for a reduction in shrivel when palms are under a moisture deficit is not clear. The thinning data indicates strongly that shrivel is not associated with a failure of the palm to accumulate sufficient carbohydrates to supply the ripening fruit with its normal requirements. The most severe shrivel injury developed in 1949 and 1953 when extensive typical rain damage occurred. This suggests that shrivel is a moisture relationship produced in some way by changes in atmospheric moisture. It may be postulated that the shrivel in the Maktoom variety is induced by injury to the internal ground cells or vascular tissues caused by excessive moisture. Such a situation may be specific with the Maktoom variety which does not normally have excessive external checking and blacknose.

The reduction in size of the fruit has been previously considered as a possible factor. However, the recent work of Nixon in 1954 (6) suggests that small Deglet Noor fruit is as susceptable to rain damage as large fruit. Furthermore Nixon has repeatedly shown (5) (6) with the Deglet Noor that excessive thinning induces checking and blacknose which is known to be caused by internal water pressure. Our data with respect to thinning on shrivel follows the same pattern. This tends to further suggest that the pre-ripening shrivel is related to abnormal internal moisture situations.

In this experiment the reduced growth rate of the leaves caused by drying the soil was not sufficient to significantly reduce the number of leaves nor the number of inflorescences produced in any year. These results differ from the first experiment conducted during 1949 and 1950 (7). This may possibly be explained by the fact that lesser stresses were placed on the palms in the present experiment. Also, in the first experiment the impact of the low soil moisture conditions upon the partially frozen leaves in 1950, caused a heavy death of older leaves and reduced the total number of leaves so that the leaf-bunch ratios were not comparable during the late summer in the different irrigation treatments. The present experiment is in agreement with the results of Furr (3) who showed that irrigation at eight week intervals did not affect bunch production.

From these two experiments over a six year period we can recommend that Maktoom palms be placed under moderate moisture stresses induced by infrequent irrigation during May, June, July, August and September to reduce rain damage and shrivel. Further reductions in shrivel will occur if a good set of fruit is obtained and only very light thinning is done.

SUMMARY

Mature Maktoom palms growing in a deep loam soil in the Salt River Valley of Arizona were irrigated under two programs during four years. Palms grown under a moderate soil moisture program were irrigated 10-12 times between January and September. Palms growing under a low soil moisture program were irrigated moderately during the winter and early spring and then only in May and July which reduced the rate of elongation of the spike leaf from 10 to 25 per cent.

Heavy rainfall in 1951 severely damaged fruit in both treatments; in 1952 moderate rainfall produced little damage; in 1953 moderate rainfall at the time the moderate soil moisture treatment was irrigated in late August caused a severe economically significant increase in checking and shrivel and loss of grade when compared with the dry plot. Unnatural ripening produced mushy fruit in 1954 and no differences between treatments occurred.

The low soil moisture treatment significantly reduced growth of the palm stem but did not influence production of leaves or inflorescences.

Changing leaf-bunch ratios from 10-12:1 to 22-26:1 produced no differences in shrivel or rain damage. Poor sets of fruit significantly increased shrivel in 1953.

Shrivel cannot be associated with carbohydrate accumulation by the palm. It has occurred most severely in years when extreme rain damage occurred which suggests that it is produced by some internal moisture relationships, induced by high atmosphere moisture. This situation may be specific with the Maktoom variety.

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NITROGEN FERTILIZATION OF DATES—A REVIEW AND PROGRESS REPORT

By J. R. Furr and W. W. Armstrong, Jr.

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Fertilizer field trials were conducted by the U. S. Date Field Station, Indio, California, during the 13-year period 1944 to 1957 to determine how much dates growing on several Coachella Valley soils would benefit from fertilization with nitrogen. This paper reviews or reports for the first time the results of those tests.

Earlier unpublished tests with other elements and date leaf analyses (Reuther 1948) indicated that in the Coachella Valley dates would be unlikely to respond to any of the major nutrient elements except nitrogen. Except for the use of manure, these field tests have been confined to chemical nitrogen fertilizers alone.

REVIEW OF PUBLISHED WORK

The first replicated test was started in a block of 9-year-old Deglet Noor palms in 1944 on Coachella fine sand (Furr, Currlin, Hilgeman and Reuther 1951). There were silty or clayey layers of varying thickness in the top 10 feet of most of this soil. Annual applications of nitrogen were made to the fertilized palms, 6 pounds per tree the first 3 years and 8 pounds per tree the next 4 years. During the first 3 years growth and yield of fertilized and unfertilized trees were about the same, but during the last 4 years the fertilized trees grew and yielded about 20 percent more than the unfertilized. Actually the fertilized palms continued to produce about the same number of inflorescences during the last 4 years as they had during the first 3, but the unfertilized palms produced fewer inflorescences after the first 3 years and their yields consequently declined. Apparently, adequate available nitrogen was liberated from organic matter in the soil to meet the needs of the unfertilized trees during the first 2 or 3 years, but then presumably a decreasing nitrogen supply caused decline in growth, inflorescence production and yield.

A similar trial was conducted for 5 years (1947-1952) on Khadrawy palms growing on soil varying from Indio very fine sandy loam to Indio loam (Furr, Currlin and Armstrong 1952). A heavy cover crop of sweet clover was grown on all plots each year. All fertilized plots received annual applications of 8 pounds of nitrogen per tree from inorganic salts. During the entire 5 years, the rates of trunk growth and the yields of fertilized and unfertilized trees were not significantly different. Even the influence of fertilization on rate of leaf growth, apparently one of the most sensitive indicators, was barely perceptible. Doubtless this soil had a fair supply of organic matter to begin with, and the nitrogen from this source in addition to that fixed by the legume cover crop provided an adequate amount for the trees.

Analyses of pinnae, seed, and fruit pulp showed that the nitrogen content of these tissues from the fertilized trees in the experiment with Deglet Noor palms was significantly higher than from tissues of the unfertilized trees (Furr and Cook 1952). Positive correlations between percentages of nitrogen in leaf samples and yields of fruit were also significant in 4 out of 6 cases in the Deglet Noor experiment. In the Khadrawy experiment fertilization caused a small and barely significant increase in the nitrogen content of pinnae, but differences in the nitrogen content of seed and fruit pulp were not significant. These results suggest that with further work leaf analysis might prove to be useful as an indication of nitrogen needs of dates.

It has been the practice in many date gardens to fertilize heavily with manure or with manure and chemical nitrogen. To study the influence of this practice on the nitrogen content of the soil, Furr and Barber (1950) took samples to a depth of 8 feet from date garden soils and from adjacent virgin soils and analyzed for nitrogen. They found that heavy fertilization of the cultivated soil resulted in little or no increase in nitrogen except in the top foot. While the percentage of nitrogen in these soils was low (less than 0.1 percent), the total nitrogen stored in the organic matter of the top 8 feet varied from about 2,000 to 15,000 pounds per acre. The higher the proportion of silt and clay, the higher was the percentage of nitrogen in the soil. These variations in nitrogen content of different soil types doubtless account for much of the variation in response of dates to nitrogen fertilization.

REPORT OF PREVIOUSLY UNPUBLISHED WORK

Experiment 1—Fertilization of Offshoots

Because date offshoots are irrigated frequently during the first two years after planting and nitrogen loss from the soil is likely to be severe as a consequence of leaching of soluble compounds, it might be expected, once an extensive root system has developed, that offshoots would respond to a high level of available nitrogen in the root zone.

To determine whether frequent applications of small amounts of nitrogen would benefit offshoots, we started a trial in April, 1948, on Deglet Noor offshoots that had been planted in Indio loam the previous May. The plants were spaced about 8 feet apart in 4 rows and to avoid excessive leaching were irrigated in basins about 4 or 5 feet in diameter from furrows that ran between pairs of rows. Thirty-seven pairs of offshoots were included in the test; one of each pair was fertilized and the other was unfertilized. From April to July about 4 grams of ammonium nitrate and from July to October about 11 grams were applied to each fertilized offshoot at each irrigation, that is, every 2 or 3 weeks.

Measurements were made of the rate of leaf growth of each offshoot, and at the end of the test samples of pinnae from each plant were analyzed for total nitrogen. If growth rate of the unfertilized offshoots was taken as 100 (leaf-growth index), then the leaf growth of the fertilized plants was 102. The difference was not significant. The pinnae samples from the fertilized offshoots averaged 1.57 percent nitrogen; those from the unfertilized, 1.49 percent—a difference of .08, which was barely significant.

The next spring some of the offshoots from this fertilizer test were transplanted to a permanent orchard planting at a spacing of 30 feet, also on Indio loam. No fertilizer was applied during the first season after transplanting, but leaf-growth measurements were made on 18 offshoots that had been fertilized and on 17 that had not been fertilized. The leaf-growth index was again 100 for the unfertilized and 102 for the fertilized, and the difference was not significant.

It appears that, although fertilization had very slightly increased the nitrogen content of the leaves, this increase made no measurable difference in the growth of the offshoots because they were already receiving an adequate supply of nitrogen. The fact that there was apparently some difference in nitrogen absorption, however, suggests that had the test been conducted on nitrogen-deficient soil, fertilization in the second season after planting would have been beneficial.

Experiment 2—Fertilization of Young Deglet Noor Palms with Annual Legume Cover Crop

In the planting of Deglet Noor trees on Indio loam made in 1949 and referred to in the account of the previous experiment, a cover crop of sweet clover was grown each winter from 1949 to 1956. In the spring of 1952 a test was begun to determine whether inorganic nitrogen fertilizer applied to a fertile soil on which a heavy annual legume cover crop was grown would improve growth of non-bearing trees, or if not, to see how long after the trees were in bearing and the shade had become too dense to grow a good legume cover the nitrogen reserves of the soil would be depleted enough for the trees to respond to added nitrogen.

The fertilized trees received 3 pounds of nitrogen per tree in 1952 and thereafter an increase of 1 pound per tree per year until 6 pounds per tree were being applied. The annual application of nitrogen was made in 3 equal parts: one in spring, one in summer and one in fall. There are 6 single tree plots of fertilized trees and an equal number of unfertilized trees separated by one guard tree on each side.

Records have been taken of gain in trunk height and growth rate of leaves since 1952, and of number of inflorescences produced and yields obtained since 1954. To 1957 the differences in growth, inflorescence production and yield have been very small and are not significant. By 1956 the shade was so dense that it was no longer possible to produce a crop of sweet clover, and the only cover in 1956 and 1957 was non-legume volunteer weeds. It is planned to continue this test indefinitely or until marked differences in yields are obtained.

Experiment 3—Fertilizer Trial on Old Medjool Palms on Porous Sand

A nitrogen fertilizer trial was begun in 1952 on a block of 17-year-old Medjool palms growing on a porous Coachella fine sand of low nitrogen content. These palms varied greatly, possibly because of differences in number of offshoots produced and injury sustained in their removal. The object of this trial was to determine whether an appreciable increase in growth and yield could be obtained on this soil by frequent applications of nitrogen. Because of the variability of the trees single tree plots were used and replicates were selected on the basis of the size and previous yields of the palms. There were 6 unfertilized plots and 6 plots that received 6 pounds of nitrogen per tree per year—1 pound of nitrogen from ammonium nitrate every 2 months. At each application the fertilizer was disked in to avoid loss of nitrogen by volatilization. All bunches that could be retained were fruited each year.

In table 1 the average trunk height, the average number of inflorescences produced, and the average yields of fruit per tree of the fertilized and unfertilized trees are shown. Nitrogen fertilization did not result in a significant gain in trunk height in any single year, but there was a small but progressive increase in trunk height and a significant increase in inflorescence production in the last two years. That a significant difference in yield of fruit was not obtained possibly is due to erratic yields of fruit caused by the fruitstalk breakage which is characteristic of the variety.

These results indicate that, even on soils of fairly low fertility, old palms with extensive root systems are not likely to show a quick and striking response to nitrogen fertilization, but rather a gradual increase in vigor and inflorescence production before an increase in yield can be expected.

Table 1. Influence of nitrogen fertilization on growth of trunks, production of inflorescences and yields of Medjool dates.

Year and nitrogen status	Trunk height[1]	Inflorescences produced	Yield per tree
	(feet)	(number)	(pounds)
1952:			
+N	20.1	......	199
−N	19.8	......	185
diff.	0.3 n.s.[2]		14 n.s.
1953:			
+N	22.1	14.2	202
−N	21.7	12.2	212
diff.	0.4 n.s.	2.0 n.s.	10 n.s.
1954:			
+N	24.2	14.8	186
−N	23.4	11.7	167
diff.	0.8 n.s.	3.1 n.s.	19 n.s.
1955:			
+N	26.4	19.7	332
−N	25.4	17.3	321
diff.	1.0 n.s.	2.4 *[3]	11 n.s.
1956:			
+N	28.2	15.8	370
−N	27.0	12.3	354
diff.	1.2 n.s.	3.5 **[4]	16 n.s.
1957:			
+N	29.7	......	......
−N	28.3	......	......
diff.	1.4 n.s.		

[1]Trunk height measured Jan. or Feb. of each year.
[2]n.s.=difference not significant.
[3]*=odds of 19 to 1 that difference is significant.
[4]**=odds of 99 to 1 that difference is significant.

Experiment 4—Comparison of Manure and Chemical Nitrogen on Deglet Noor Dates

A comparison of the effect of equal amounts of nitrogen from manure and from chemical fertilizer is being made in a cooperative trial with the T. R. Brown Date Garden in the Oasis district. This test was established in the spring of 1952 in a block of Deglet Noor trees planted in 1942 on Coachella fine sand. There are 4 trees per plot and 9 plots in each treatment. The manure plots receive about 6 to 8 pounds of nitrogen per tree per year from steer manure, and the chemical-fertilizer plots receive about the same amount from ammonium nitrate. The average yields per tree in 1953, 1954, 1955 and 1956 were, respectively, 200, 178, 203 and 200 pounds from the manure plots, and 182, 193, 207 and 247 pounds from the chemical-fertilizer plots. Differences, so far, have not been significant, but we hope to continue this trial for some years to ascertain the long-term effect of manure alone versus chemical fertilizer alone.

Table 2. Influence of nitrogen fertilization on growth of trunks and leaves, production of inflorescences and yields of Deglet Noor dates.

Year and nitrogen status	Trunk height	Leaf growth index[1]	Inflorescences produced	Yield per tree
	(feet)		(number)	(pounds)
1954:				
+N	20.5	119	11.9	174
—N	20.7	100	12.3	181
diff.	0.2	19	0.4	7
1955:				
+N	22.4	129	19.5	280
—N	22.2	100	16.3	258
diff.	0.2	29	3.2	22
1956:				
+N	24.6	126	17.0	282
—N	23.6	100	13.5	221
diff.	1.0	26	3.5	61
1957:				
+N	26.7	......	18.8	......
—N	24.8	......	12.7	......
diff.	1.9	......	6.1	......

[1]Leaf-growth index: —N=100.

Experiment 5—Trial of Heavy Nitrogen Fertilization to Improve Fruit Quality

Some relatively heavy soils seem poorly suited to the Deglet Noor variety. At the U. S. Date Field Station there is a small block of such soil (Indio very fine sandy loam underlain by sand at 4 or 5 feet) which was planted to Deglet Noor palms in 1940 to 1943. This is the second planting of dates on this soil, which has a history of more than 30 years of producing fruit of low quality. To see what effect wide variations in water and nutrient supply may have on the quality of the fruit produced by these trees, we began a test in April, 1954, in which we apply water to 3 different plots at rates of 6, 10 and 14 acre-feet per acre. One half of each irrigation plot was fertilized very heavily, as follows: 1954, 9 tons of manure per acre and 3 pounds of inorganic nitrogen per tree; 1955, 8 tons of manure per acre, 3 pounds of inorganic nitrogen per tree; 1956, 19.6 tons of manure per acre, 1 pound of inorganic nitrogen per tree.

This block was too small to provide replications of the treatment; but if, after more than 30 years of yields of low-quality fruit, the trees in a treatment show a marked improvement in fruit quality, the change is likely to be related to the treatment.

We are not concerned here with the effect of the variations in amounts of water applied, but there seem to have been no differences that could be related to water supply. In table 2, the average values obtained for trunk height, leaf-growth index, number of inflorescences produced and yield from 1954 to 1957 are listed. These data suggest that the heavy fertilization is improving growth, inflorescence production and yield of the fertilized trees. There were slightly higher percentages of "naturals" and somewhat lower percentages of "drys" from the fertilized trees than from the unfertilized trees, but the quality of all fruit from all trees every year of the test has been so very poor that little significance can be attached to the small differences noted. Up to 1957 the trees were allowed to carry all the bunches produced except broken or defective ones. Because of the marked difference in number of inflorescences produced in 1957 by the fertilized and unfertilized trees it seemed advisable to remove a few bunches from the fertilized trees. This reduction in crop may improve the quality of fruit produced by the fertilized trees in 1957.

DISCUSSION AND CONCLUSION

Soils of the Coachella Valley on which dates are grown vary greatly in the amount of nitrogen they contain. In the virgin state the loams are relatively high in nitrogen and the sands are relatively low. The application of very large amounts of nitrogenous material, such as manure, in an attempt to build up the soil after it is in cultivation is only partly effective. Not much change is made in the total nitrogen content of the soil except in the top foot, and this effect is temporary. Applications of nitrogen fertilizers greatly in excess of the needs of the trees are largely wasted because of the relatively rapid decomposition of organic matter and disappearance of nitrogen in other forms. Some of the soils in the virgin state are fertile enough to supply palms with adequate nitrogen for several years without fertilization, and others are so low in nitrogen that economical production on them cannot be expected without additions of fertilizer. Even in soils so low in nitrogen as seriously to limit yields a quick increase in yield following fertilization should not be expected. Several years may be required for much increase in yield because, apparently, the growth of leaves and the production of inflorescences must first be increased.

From the results of these tests, it appears that it would be good practice to provide each year a nitrogen supply adequate for good growth. This may be accomplished with either manure or inorganic nitrogen, and so far neither seems to have the advantage. Unfortunately, there appears to be no way to avoid rapid increase in trunk height if maximum yields are to be secured.

As yet, little is known about the amounts of nitrogen needed by dates on the different soil types. In these tests conducted on several soil types to see how dates would respond to nitrogen fertilization we assumed on theoretical grounds that 6 pounds of nitrogen per tree per year would be adequate. It is likely that less would be needed where losses from leaching and volatilization are small.

SUMMARY

In a series of nitrogen-fertilizer trials on Coachella Valley soils dates showed little or no response to added nitrogen on some soils and slow response on others. Nitrogen fertilization of dates on a nitrogen-deficient soil does not immediately increase yield because, apparently, an appreciable increase in number of inflorescences produced requires more than one year.

A survey of the nitrogen content of date-garden soils and adjacent virgin soils showed that the total nitrogen in the top 8 feet varied from about 2,000 pounds per acre in some sands to about 15,000 pounds per acre in some loams, and that heavy fertilization of the cultivated soils for years has resulted in little increase in their total nitrogen content except in the top foot. Doubtless, these differences in natural fertility account for much of the difference in response to nitrogen observed on different soils. In three trials, carried out on soils varying from fine sand to very fine sandy loam, annual additions of 6 to 8 pounds of nitrogen per tree resulted in increased growth and inflorescence production. In one, after 3 years, the fertilized trees produced about 20 percent more fruit than the unfertilized.

In two trials on loam soils trees fertilized annually with 3 to 8 pounds of nitrogen for 5 years showed no greater growth or yield than unfertilized trees. Growth of offshoots in a nursery on loam soil was not improved by frequent small applications of nitrogen during one summer.

During the first 5 years of a test with bearing Deglet Noor palms on a fine sand, yields of trees supplied annually with 6 or 8 pounds of nitrogen from manure have been about the same as those supplied with equal amounts of nitrogen from chemical fertilizers.

The results of this work show, as might be expected, that the light, sandy soils are low in total nitrogen and that unfertilized dates on these soils soon suffer nitrogen deficiency. Because a long time is required after nitrogen has been applied for nitrogen-deficient date palms to attain maximum production, it probably would be good practice to provide each year a nitrogen supply adequate for good growth of the palms.

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DOES QUALITY PAY?

By Hillman Yowell

California Date Growers' Association

"Grower Acre off Tree Earnings" is the amount of money returned to the grower after picking costs are removed and the fruit is ready for delivery to the packinghouse. This chart is based on earnings on marketable pounds only. This report is based on two complete crop years—the 1953-54 and the 1954-55 crops. The 1953-54 was a crop of large volume, average to good quality. The 1954-55 was a crop of smaller volume, below to average quality. Past records show that this alternating fluctuation of volume and quality is the rule in date production.

The numbers represent 100's of dollars earned per acre. We have divided the date producing areas into three sections—"A" representing the eastern or Oasis area—' B" the central, including Indio west to La Quinta and east to the high school—"C" the Indian Wells and west area.

We have selected two growers from each section. The green line represents growers who consistently use good growing practices. The red line represents growers who consistently use poor growing practices. The broken line is the average between good and poor growing practices.

Section "A" — The green grower averaged $386 per acre for the two years—the red grower averaged $283 for the same period.

Section "B"—The grower following good growing practices averaged $784 per acre and the grower following poor growing practices average $386 per acre.

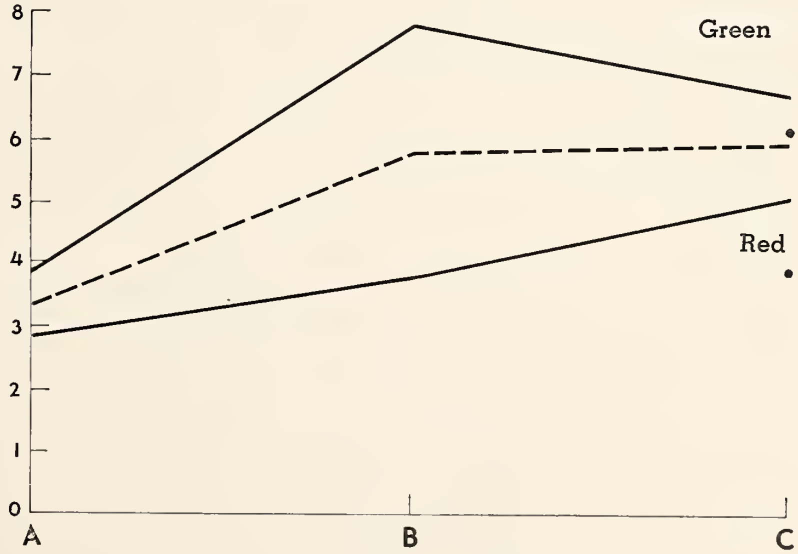
Section "C" — The green grower averaged $683 per acre and the red grower $520 per acre.

The green dot is the average return for the three sections of growers using good growing practices—$618 per acre average.

The red dot is the average return for the three sections of growers using poor growing practices—$396 per acre average.

The difference in return between the two growers in "A" section was $103 per acre—the difference in "B" section was $398 per acre — and the difference in the "C" section is $163 per acre.

Fluctuations in the return per acre between the two years was greater in the "A" and "C" areas, the "B" area being more of a stable section.



2-year average 1953-54 and 1954-55 crops.

TRIAL OF SEVERAL HERBICIDES FOR CONTROL OF NUTGRASS IN COACHELLA VALLEY, CALIFORNIA

W. W. Armstrong, Jr.

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Nutgrass, *Cyperus spp.*, common noxious weeds in Coachella Valley, often form dense sods in date palm plantings. Older, deeply rooted palms apparently do not suffer from this competition, but when old palms are removed the heavy infestation of nutgrass may prevent successful use of the land for other permanent crops. When date offshoots are transplanted from an infested area nutgrass tubers may be moved with them and infest a previously clean field.

Nutgrass is propagated chiefly by tubers, for seed germination is very low (5, 6). While purple nutgrass, *Cyperus rotundus*, is easier to control than yellow nutgrass, *C. esculentus*, (6, 7) both species are much more difficult to control in Coachella Valley than in humid, tropical areas or in regions that have killing winter temperatures. High summer temperatures, light, friable soil and abundant soil moisture favor the production of dense tuber populations to depths of 18 inches.

Ordinary tillage practices, designed to control seedling weeds, serve only to spread the tubers and increase the stand of nutgrass in infested fields. Special methods of cultivation have been developed to reduce the tuber population, but effective control is difficult (3, 7, 8, 9, 10). Some of the tillage plans involve air drying the soil occupied by the tubers. These methods cannot be used for permanent crops.

Frequent irrigation can leach soluble soil-applied herbicides so rapidly that toxic concentrations cannot be accumulated in the root zone. It is probable that low humidity during the growing season prevents efficient absorption by the foliage of hormone-like herbicides.

Chemical control of nutgrass has been investigated intensively in widely scattered regions and has given excellent results under certain climatic conditions. In Puerto Rico, Loustalot, Muzik and Cruzado (5) found that monuron (the presently accepted name for the compound previously known as CMU, 3-p-chlorophenyl-1, 1-dimethylurea) gave excellent control of purple nutgrass, but that 2,4-D (2,4-dichlorophenoxyacetic acid), sodium pentachlorophenate and TCA (sodium trichloroacetate) were only partically effective. Winchester and Rodgers (11) reported that on this species in Florida the compounds sodium chlorate and 5TCO.6 (composition unpublished) were somewhat more effective than TCA, monuron or 2,4-D. Effective control of purple nutgrass with ATA (3-amino-1,2,4-triazole) was obtained by Burt (1) in Florida and by Hauser, Thompson and Stacy (4) in Georgia. Burt showed further that 2,4-D and dalapon (sodium 2,2-dichlorpropionate) gave good to excellent control. Orsenigo and Smith (6) demonstrated good control of yellow nutgrass with TCA under New York conditions. Rehm (7) showed that in South Africa 2,4-D was more effective in controlling purple nutgrass than were TCA, monuron, or 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) but that there were only slight differences among the various 2,4-D formulations.

Several soil fumigants, including chlorobromopropene, D-D (a mixture of 1,2-dichloropropane and 1,3-dichloropropylene), chloropicrin, ethylene dibromide and methyl bromide, have been shown to be very effective (2, 5) on both species.

Chemical control, in spite of some known limitations on its usefulness, was believed to be the most feasible approach to the nutgrass problem in Coachella Valley when the present studies were begun in 1954.

EXPERIMENTAL METHODS AND RESULTS

The trial area had a dense stand of purple nutgrass. Mature palms were removed from this field in 1941. When the land was replanted with date offshoots nutgrass competed strongly with the young palms, their growth was slow and erratic, and in 1952 they were removed.

With one exception these experiments were of either random-block or Latin-square design and the results were subjected to statistical analysis.

1954. In an initial trial begun in June 1954 on mature nutgrass, 2,4-D and 2,4,5-T were compared at several rates. The treatments were 1.5, 3, 6 and 12 pounds of 2,4-D acid equivalent per acre as an unspecified formulation[1] and 1.5, 3, 6, and 12 pounds of 2,4,5-T acid equivalent as an alkanolamine salt[2]. The plots were resprayed every six weeks from June to October for a total of five times. Visual evaluation of the treated plots showed that the highest dosage rates were most effective, that 2,4-D was more effective than 2,4,5-T, and that all treated plots were superior to the untreated control plots.

In a later trial three formulations of 2,4-D were compared. The various forms of 2,4-D have differed slightly in their effectiveness in areas other than Coachella Valley (5, 7, 11). After a total of 4 treatments during August to October there were no visible differences among 2,4-D treatments at the rate of 6 pounds acid equivalent per acre as an alkanolamine salt[2], a low-volatile ester[2] or an unspecified formulation.[1]

[1]*Supplied by American Chemical Paint Co.*

[2]*Supplied by Dow Chemical Co.*

1955. In a trial of several herbicidal materials the treatments and rates per acre were 2,4-D ester, 40 pounds acid equivalent; dalapon[2], 40 pounds acid equivalent; ATA[3], 40 pounds; 5TC0.6[4] 100 pounds; sodium chlorate[5], 500 pounds; a mixture of sodium chlorate and monuron[5], 500 pounds; a mixture of sodium chlorate and borax[5], 500 pounds; monuron[6], 150 pounds; and TCA, 400 pounds. All the treatments were applied in May, when the nutgrass was in the flowering stage. The plots receiving 24-D or dalapon were retreated at intervals of 4 to 6 weeks for a total of four applications in 5 months. The other plots were not retreated. By the end of October the only plots that were visibly different from the untreated controls were those that received 2,4-D or monuron.

1956. The following materials and rates per acre were used: monuron, 150 and 300 pounds; CET[7] (2-chloro-4,6 - bis - ethylamino - s - triazine), 40 pounds active; CDT[7] (2, chloro-4,6-bis-diethylamino-s-triazine), 40 pounds active; ATA, 40 pounds active; 2,4-D amine, 40 pounds acid equivalent; MCPA amine[2] (alkanolamine salts of 2-methyl-4-chlorophenoxyacetic acid), 40 pounds acid equivalent; and 2,4-D amine absorbed in vermiculite[8], 40 pounds acid equivalent.

[3]*Supplied by American Cyanamid.*

[4]*Supplied by B. F. Goodrich.*

[5]*Supplied by Chipman Chemical Co.*

[6]*Supplied by E. I. DuPont de Nemours & Co.*

[7]*Supplied by Geigy Agricultural Chemicals*

[8]*Supplied by California Zonolite Co.*

All materials except monuron were reapplied at intervals of six weeks from June to October. A tuber count

in December showed populations of 125 to 200 tubers per cubic foot in the top foot of soil in the control plots. Plots in which control of plant tops was excellent and regrowth was not occurring had populations of one or two up to as many as 50 live tubers per cubic foot.

Monuron, at either rate of application, was the most effective material. It reduced the live tuber population to below one percent of that in the untreated control plots. 2,4-D, CDT and CET gave about 95 percent control. The effectiveness of MCPA was less than that of 2,4-D. ATA and 2,4-D in vermiculite reduced the tuber count to about 50 percent of that in the controls.

Serious injury to sensitive crop plants has resulted from the use of heavy applications of 2,4-D. In areas where sensitive plants are grown, the use of 2,4-D as a liquid application at the high rates necessary to control nutgrass is not generally permitted. It was hoped that volatilization of the 2,4-D would be prevented by cultivating 2,4-D absorbed in vermiculite into the surface soil, but that the concentration of 2,4-D in the root zone would be lethal. Cotton planted in rows across a plot treated in this way showed typical 2,4-D injury at the end of the rows, 20 feet beyond the treated plot.

In August, D-D[9], normally used as a soil fumigant, and allyl alcohol[9] were tried as soil drenches in an unreplicated trial. The rate in both cases was one gallon of active material per hundred square feet. Only D-D gave appreciable control lasting for several months.

DISCUSSION AND CONCLUSION

Chemical control of nutgrass in the Coachella Valley presents unique problems which render valuable measures employed elsewhere either unfeasible or ineffective. No chemical measures detailed herein eradicated nutgrass, but several materials show some promise for control and warrant further study.

While monuron was the most effective material used, it is expensive, may remain in the soil in quantities toxic to some crop plants for long periods, and did not eradicate nutgrass. 2,4-D is relatively inexpensive, but since it cannot be used at effective rates in this area and was less effective than monuron it is of little practical importance.

The failure in these tests of herbicides containing sodium chlorate, TCA and allyl alcohol is probably due to the excessive solubility and rapid leaching of these compounds through the tuber-occupied soil. Sodium chlorate and TCA have been used successfully for sterilizing railroad, powerline and other rights-of-way for extended periods and allyl alcohol is valuable as a temporary sterilant for tobacco seed beds.

[9] *Supplied by Shell Chemical Corp.*

There are serious handling hazards or difficulties associated with several of the materials. Allyl alcohol and D-D are volatile and the vapors are extremely irritating to the eyes and nose, requiring the use of respirator and protective goggles and clothing. 5TC0.6 and monuron are highly toxic and require considerable care in handling. The fire hazard is extreme when Allyl alcohol, D-D, or sodium chlorate is used. D-D is insoluble in water and therefore is difficult to apply in suspension as a soil drench. The residual effects of D-D and monuron may be long lasting for some crop plants.

Further tests should be made of the experimental compounds CET and CDT as sprays and of D-D as a soil drench in spite of difficulties in handling the last compound.

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Typical color of fresh Deglet Noor dates and of those with various moisture contents after storage at 0°, 40°, and 75° F.

39
Before storage

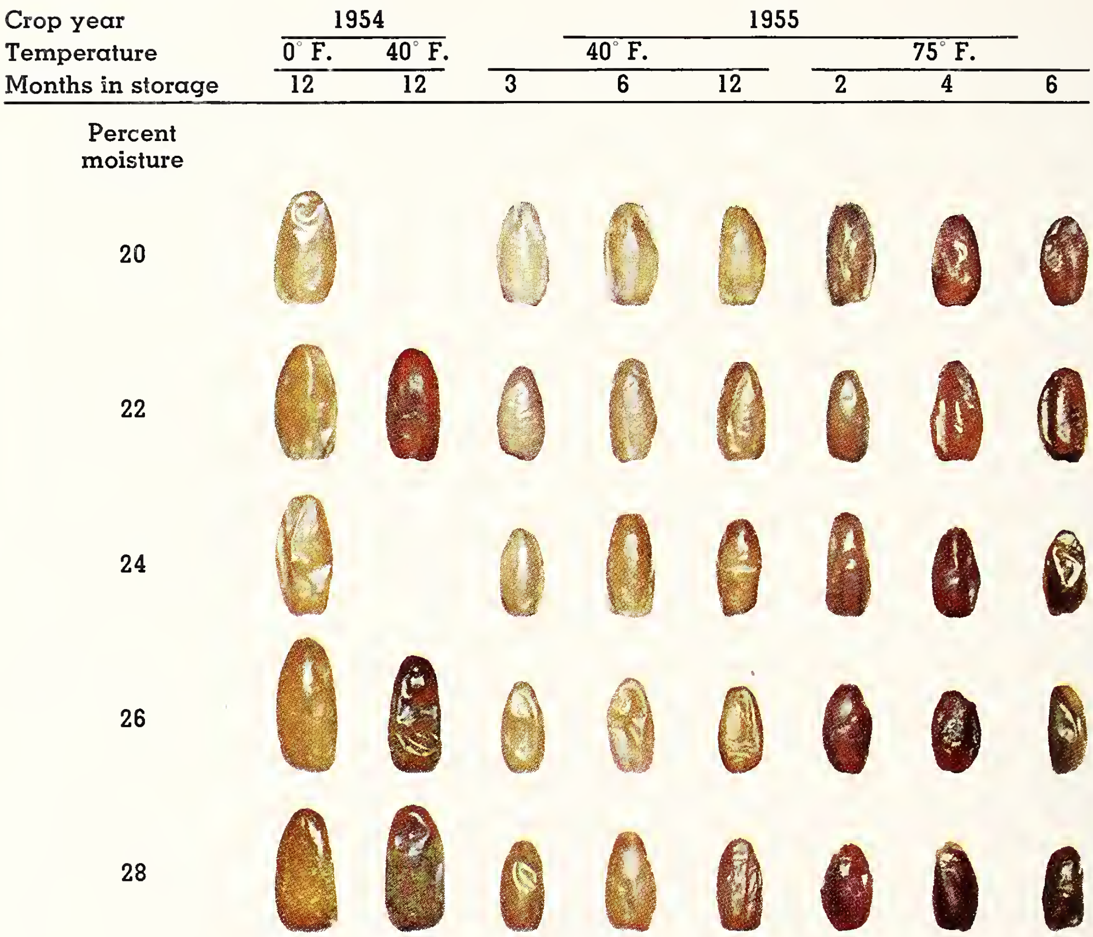

PLATE 1.

THE RELATION OF MOISTURE CONTENT TO RATE OF DARKENING IN DEGLET NOOR DATES

By G. L. Rygg[1]

Agricultural Marketing Service, Pomona, California

At the 1956 meeting of the Date Growers' Institute I presented results of a study of changes in color, flavor, and acidity of Deglet Noor dates during storage (1). At that time most of the emphasis was on the effect of differences in temperature. Moisture content was of secondary consideration.

The report this year also is on the Deglet Noor variety but emphasizes the effect of differences in moisture content on color.

MATERIALS AND METHODS

At the height of the 1955 harvest season 560 fruits of the Deglet Noor variety were enclosed in small individual bags of 150 gage polyethylene. One-half of these were stored at 75° F. and the remainder at 40° F. The dates were chosen to cover a range of moisture contents from 14 to 38%, and most of the range was represented at each examination. Each date was treated with 2 drops of a mixture of 85% methyl formate and 15% ethylene oxide to prevent mold and fermentation.

The dates stored at 75° F. were examined after 1, 2, 4, and 6 months, and those stored at 40° F. after 3, 6, 9, and 12 months.

Since no adequate method was available by which quantitative measurements of color could be made, color photographs were taken at the beginning and end of storage. Moisture content of each date was measured by drying under vacuum at 158° F.

RESULTS AND DISCUSSION

After 1 month at 75° F., dates with a moisture content of 26% or more had darkened markedly. There was little difference among dates containing 18% moisture or less. After 2 months there was progressive darkening as the moisture content increased above 16% and dates with a moisture content of 24% were too dark to be attractive. After 4 months, dates with a moisture content of 22% were too dark to be attractive. After 6 months, those with more than 18% moisture were too dark.

After 3 months at 40° F., dates with 30% moisture were too dark to be acceptable whereas those with 28% or less were acceptable. After 6, 9, and 12 months dates with a moisture content of 28% or more were darker than desirable whereas those with 26% or less were acceptable.

Figure 1 gives the results graphically. Plate 1 illustrates typical color of dates with 20 to 28% moisture after storage at 75° and 40° F. for periods up to 6 and 12 months, respectively, in 1955. Photographs of representative dates from the 1954 crop after storage for 1 year at 40° and 0° F. also are included (1). The dates from the 1954 crop stored at 40° F. darkened more than those with the same moisture content from the 1955 crop, especially at the higher moisture values. The reason for this difference has not been determined. Storage at 0° F. in 1954 resulted in appreciably better retention of color than storage at 40° F. The color of the dates before storage is represented by the photograph at the top of plate 1. The prestorage color was the same in the two seasons.

These results give the approximate limitations of moisture content of stored Deglet Noor dates with respect to color, but other factors must be considered in determining their storage life. Dates with moisture contents of 18 to 20% or lower retain good color, even at 75° F., but such dates are usually rather unattractive and hard-textured. Those with more than 25% moisture may become sirupy and are readily crushed unless they are held at a low temperature. Loss of flavor is more pronounced as the moisture content is increased.

Dates held at the commercially available temperature of 32° F. will keep better than at 40° F. as used in the present experiment.

SUMMARY

Deglet Noor dates with moisture contents from 14 to 38% were sealed in individual polyethylene bags and held for periods up to 6 months at 75° F. and 12 months at 40° F.

The degree of darkening was evaluated after 1, 2, 4, and 6 months at 75° F. and after 3, 6, 9, and 12 months at 40° F.

The results suggest that as far as color is concerned dates with 24, 22, 20, and 18% moisture may be stored as long as 1, 2, 4, and 6 months, respectively, at 75° F. At 40° F. the maximum storage period for dates with 28% moisture in 1955 was 3 months whereas those with 26% or less could be held 12 months. Moist dates stored at 40° F. darkened sooner in 1954 than in 1955.

Other factors such as appearance, texture, sirupiness, and crushability must be considered in choosing the moisture content at which dates are to be marketed.

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[1] *Dates used in this work were provided by the Date Administrative Committee.*

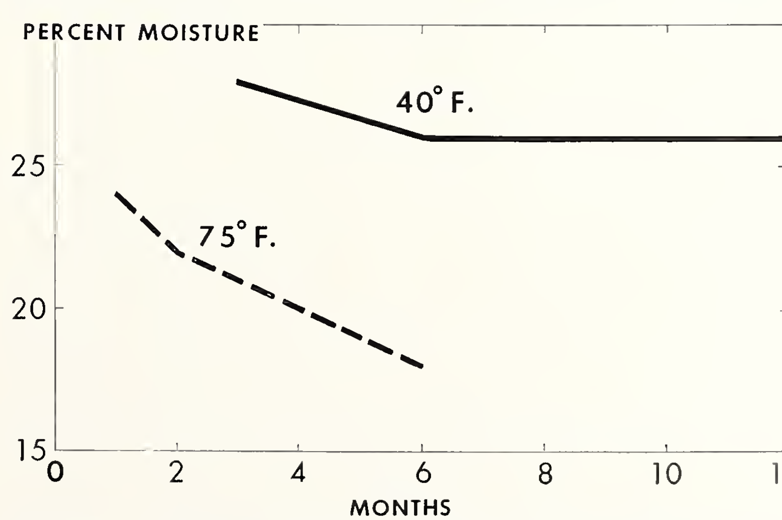

Figure 1. *Maximum moisture content that permitted retention of acceptable color in stored Deglet Noor dates in* 1955.

AGRICULTURAL DRAINAGE IN COACHELLA VALLEY

By Lowell O. Weeks

General Manager-Chief Engineer, Coachella Valley County Water District

Ladies and Gentlemen: I think I have talked to most of you about farm drainage many times. Because of the fact that most of you date growers are not in areas of high water tables, I would like to give you some background about what we in the Water District are doing to correct problems in Coachella Valley.

WHAT CAUSES DRAINAGE

Natural rainfall — every drop of rain that percolates below the ground surface can cause some drainage problems.

Upper lying owners—upper lying farms can cause drainage problems to lower lying farms because of lateral movement of underground water.

Irrigation water—your own overuse of irrigation water is the most direct cause of high water tables.

REASONS FOR DRAINAGE WORKS

The high water table that is developed because of return irrigation water in Coachella Valley is high in total salts.

We must remove the high water table and in so doing the salts are also removed. If this is not done the salt in the soil will increase in concentration and the farm land will become non-productive.

DEVELOPMENT OF DRAINAGE PROGRAM

Back in 1927 about 45 alkali wells were put down to observe the water table, and the water levels were recorded for several years. During the following years as the deep well water tables dropped the alkali wells disappeared.

In 1945 it was felt that with the importation of Colorado River water a drainage problem would develop and a Memorandum of Agreement was signed by interested agencies. These agencies were the Coachella Valley County Water District, the University of California, and the U. S. Regional Salinity Laboratory. With the signing of the 1947 distribution system contract, the Bureau of Reclamation entered the program, now known as the "Coachella Valley Drainage Cooperators." The investigations and research are done by all of the interested agencies. Design and construction of drainage facilities are the sole responsibility of the District.

The investigations commenced with a two mile grid of drainage observation wells which were hydraulic rotary drilled wells with a two-inch diameter casing. Piezometer wells, ⅜-inch diameter black iron pipe jetted into the ground, were the next type of observation wells. There are now 1500 of these in the valley and they are installed at every section and half section corner. We are able, by studying all of these observation wells, to obtain information on free and confined water bodies, perched or semi-perched water bodies, variations in pressure head with depth below ground surface, vertical and horizontal flows, and subsurface profiles.

The next program was to determine and find out all about the different methods of controlling ground water. This was an irrigation pumping area so the first study was by vertical drainage wells. The District put in six experimental drainage wells in various locations throughout the valley. The conclusion was reached that as far as irrigation return water is concerned it could not, at this time, be economically controlled by wells. In the Middle East they use open drains but the lands in Coachella Valley are too valuable for this type of drainage control. Other methods of control are "French Drains," a type of underground drainage constructed by filling a ditch with stones and gravel; "Gopher Drains," made by pulling a slug of metal on a shank through the ground; and farm tile drainage systems using underground tile.

WATER DISTRICT DRAINAGE PROGRAM

It is the policy of the District to furnish outlets for the farm tile drainage systems and to dispose of this subsurface drainage water in either open or closed drains. The District will furnish an outlet within a reasonable distance of each farm ownership which is usually one-quarter of a mile as the drains are, in general, constructed on one-half mile intervals. Open drains are used from the Salton Sea to the boundary of Improvement District No. 1 and underground pipe drains are being used in the more highly developed areas. We are attempting to have available a seven foot outlet for each farm, the District drains being laid from eight to ten and a half feet below the ground surface.

There is no place in the world where this type of drainage is being used. We have visitors from all over the world and, after dates, the drainage works are the first thing they want to see.

FARM TILE DRAINAGE SYSTEMS

You, gentlemen, are interested in farm tile drainage system on your individual farms which are generally laid at depths of six to seven feet. The depth is limited by economics as well as the depth that will give adequate drainage. It is possible to install drain tile too deep for good drainage results. The Citrus Laboratory at Riverside believes that citrus can be grown over a five foot table which is feasible to maintain by tile drainage. The cost of a farm tile drainage system is about $100.00 per acre. However, if you can take advantage of the Agricultural Stabilization Program, the cost to you will be about $60.00 to $70.00 per acre. At the present time 9000 acres on 130 farms have been tiled in Coachella Valley.

DRAINAGE IN DATES

I have always read that "dates do best with their feet in the water and their heads in the sky." A date can grow in high saline water, but we have reason to believe that with the highly saline water which we have in Coachella Valley there will be damage to date crop production. We further believe that we will see farm tile drainage system installed in all producing date Gardens in Coachella Valley when a high water table arises. The investment in date gardens is too great to allow the trees to be damaged beyond repair.

CONCLUSION

The Water District, in setting up its research and investigational program, is able to determine the most suitable type of drainage for use here in Coachella Valley. We are more able to install and design adequate farm tile drainage now than ever before.

EXPERIMENTAL PLANTING OF IMPORTED VARIETIES OF DATES IN THE SAN JOAQUIN VALLEY OF CALIFORNIA

By Roy W. Nixon
U. S. Date Field Station, Indio, California

Valuable information about the behavior of imported varieties of dates in the San Joaquin Valley of California has been obtained from an experimental planting of W. L. Richardson about 5 miles southeast of Porterville. Mr. Richardson, a citrus grower, became interested in testing dates in that locality through his son, Hilton Richardson, who for many years was Farm Advisor in the Coachella Valley, California, where about 90% of the commercial date production in the United States is centered. From 1936 to 1948 Mr. Richardson planted specimen offshoots of eommereial and promising varieties of dates until he had acquired 17 imported varieties, 2 of which he discarded leaving 15 in his collection.

On October 29 and 30, 1956, I made a trip to Porterville and in company with Mr. Richardson examined the palms in his variety collection and discussed the results. This was the first time I had seen these palms during the ripening season. It was fortunate for the record that the trip was not longer delayed, for on November 27 Mr. Richardson's many friends were saddened by his sudden death just 6 days after he had celebrated his 84th birthday. Mr. Richardson had many and varied interests, but his chief concern was fruit growing and he always included in his home orchard a test plot of new and different varieties of fruits and nuts whieh never failed to arouse his enthusiasm.

VARIETIES AND THEIR BEHAVIOR

The date planting is located on a hillside in the citrus belt on Porterville adobe soil. The varieties included in this planting are listed below; the date of planting is noted in parenthesis; the height to the bud was estimated; time of ripening is based on records from commercial date areas; variety behavior and ratings are from Mr. Richardson's experience. There is only one palm of a variety unless otherwise stated.

Amir Hajj (1946). 8 ft.; midseason in ripening. A good date, but it would be better in this locality if it ripened earlier.

Barhee (1948). 5 ft.; date ripening. There has been considerable rain damage: checking, splitting, and rot.

Braim (1946). 3 ft.; early ripening. Fruited for the first time in 1955 with only one bunch, but it appeared to have some promise.

Dayri (1948). 5 ft.; midseason in ripening. Fruited for the first time in 1956; poor set; all fruit soft, not outstanding, but may be better later.

Deglet Noor (1936). 25 ft.: 1 palm (1948), 6 ft.; late ripening, beginning here about November 1 and continuing through January. Fruit is very susceptible to rain damage and tends to rot if left to ripen on the palm, but by picking as the fruit began to soften and completing the ripening in a maturation chamber Mr. Richardson obtained fruit of good quality.

Halawy (1944). 10 ft.; early ripening. This palm bore a little fruit the third year after planting. Quality good; very little rain damage.

Hayany (1946?). 7 ft.; early ripening. Fruit about half normal size for this variety; quality poor.

Hilali (1944?). Palm was dug out because fruit ripened very late (March and April) and the leaves were very badly damaged by low temperatures which did not injure most of the other palms.

Kalara (1948). 2 ft.; early ripening. Has not fruited.

Khadrawy (1944). Early ripening. Palm dug out because fruit was too small.

Kustawy (1946). 9 ft.; midseason in ripening. Fruit typical of this variety, small but good; does not ripen early enough.

Medjool (1944). 10 ft.: early ripening. Fruit large and attractive; very little damage from rain and high humidity.

Tadala (1946). 8 ft.; early ripening. Fruit large, very little checking; considered a good date; flowered third year after planting.

Tazizoot (1939). 18 ft.; early ripening. In this locality, fruit drops badly, both early in season and just before ripening; as it ripens it loosens at stem end and permits insect infestations.

Thoory (1948). 3 ft.; late ripening. Fruit about half normal size. Palm too small and has not fruited long enough for final judgment.

Tozer Zaid Khala (1946). 7 ft.; early ripening. A fair date.

Zahidi (1946). 8 ft.; midseason in ripening. Fruit too small, about half normal size.

These palms when examined on October 29, 1956, were all in good growing condition; some, like Deglet Noor and Tazizoot, had made almost as good growth as might have been expected in Coachella Valley; others, like Thoory and Kalara, had made very little growth since they were planted and were not large enough for normal fruiting. Fruit begins to ripen here about six weeks later than in Coachella Valley. The earliest varieties like Medjool, Tazizoot, Tadala, Hayany, and Tozer Zaid Khala begin ripening about October 1. The latest varieties like Deglet Noor begin about November 1 or a little later. Midseason varieties begin ripening between these dates. The earliest fruit usually ripens enough on the palm to be eaten; but later in the season as the weather cools, ripening is very slow, and because of rains and damp weather it is desirable or necessary to pick the fruit as it begins to soften and complete the ripening off the palm in a maturation chamber with controlled heat and humidity. A small cabinet heated by an electric unit was made by Mr. Richardson, and it has been very satisfactory.

Fruit ripening late in this locality is usually on the palm during some of the rainy and damp weather of winter. Such conditions not only delay ripening, but prevent the drying or curing which occurs in warmer and drier weather. This fruit remains soft and often becomes somewhat "slimy" (Mr. Richardson's description). Drying under controlled conditions off the palm will usually be necessary if such fruit is to be kept for a while. Insects, which are likely to concentrate in rather large numbers on fruit in an isolated planting of soft dates in any locality, have been troublesome and sometimes do considerable damage. To prevent damage it may be necessary to enclose the bunches in cheese cloth or similar light weight material in addition to paper covers for rain protection.

Mr. Richardson's first choice of date varieties for planting near Porterville was the Medjool because of its large size, good quality, and lack of serious rain damage. His second choice was Deglet Noor because of its better-than-average quality in spite of its susceptibility to rain damage and its late ripening which make off-palm maturation necessary. For third

choice two dates were listed as about equal—Tadala and Halawy; the former is the larger but both are early-ripening dates of good quality, which have usually ripened without serious damage from fruit rot. Several other varieties might have some promise but had not yet been fruited long enough for Mr. Richardson to determine their behavior.

CLIMATIC CONDITIONS

The climatic data given in Table 1 explain differences observed in the behavior of dates at Porterville and Indio. The average maximum temperature for the growing period (May-October) is about 9 degrees lower at Porterville than at Indio. Mr. Richardson was of the opinion that the summer maximum temperatures at his ranch were slightly lower and the winter minimums slightly higher than at the station nearer town where the official records were obtained. The average rainfall during July, August and September is actually somewhat less at Porterville than at Indio, but even the earliest varieties do not begin ripening at Porterville until October 1, after which the rainfall is higher there. The higher rainfall and lower temperature while the fruit is ripening at Porterville explain why it does not cure or dry as readily as at Indio.

Temperatures at Bakersfield on the floor of the Valley some 60 miles southwest are very similar to those of Porterville and the lower rainfall in late fall suggests that conditions may be slightly more favorable during the ripening season. On the other hand, climatic conditions at Winters in the Sacramento Valley are definitely less favorable for dates than at Porterville.

Temperatures at Riverside and El Cajon on the coastal slopes of southern California are below those of Porterville, Bakersfield and Winters, but occasionally extra early seedling palms have been known to mature fruit there. At the Citrus Experiment Station, Riverside, specimen palms of 9 commercial varieties of dates (all except Saidy represented at Porterville) have been growing since 1933 and so far as known they have never matured fruit, but it should be added that they have seldom been pollinated or given any special attention comparable to the care given Mr. Richardson's planting at Porterville. The same can be said of specimen palms of Deglet Noor and Zahidi varieties growing near El Cajon.

Climatic data are also given in Table 1 for Elche, Spain, which represents the only locality in Europe where date culture is of any importance. It is obvious that conditions there are marginal for dates, and certainly no better than those at Porterville. Dates at Elche are harvested over a long period of time, partly because they are nearly all seedlings and consequently very variable and partly perhaps because minimum temperatures in winter are almost unbelievably high and might be responsible for a wide spread in flowering. Most of the ripening there occurs from late fall through the winter, reaching a peak in December; this may be a trifle later than the season at Porterville, but it is not very different.

OTHER DATE PLANTINGS

Mr. Richardson was not the first to plant imported varieties of dates in the San Joaquin Valley. In fact, a number of young palms from the first successful importation by the United States Department of Agriculture from the Old World were planted at the old State Experiment Station near Tulare in 1890, but these proved to be inferior types and their behavior did not encourage further plantings. Farther north, seedling palms on the Wolfskill ranch at Winters near Davis, California, received considerable publicity in the late 70's for the edible fruit produced, and suggested the possibility of growing dates in the warm interior valleys of California.

In 1914 W. R. Nutting of Fresno attempted to organize a date association for the San Joaquin Valley. Many date seeds were planted during the next few years. On March 20, 1919, the Fowler Ensign put out a special edition devoted to the promotion of date culture in the San Joaquin Valley and among the illustrations are a number of seedling date palms bearing crops of fruit in various localities in that area. There is one view of a large nursery belonging to W. R. Nutting, 18 miles east of Fowler, in which there were said to be 14,000 seedling date palms. Not many of these palms appear to have survived, but here and there throughout the San Joaquin Valley date palms will be found and occasionally there is one which matures fruit when pollinated. The old Wolfskill place farther north was subsequently acquired by the University of California and, under the direction of the Division of Pomology of the College of Agriculture at Davis, specimens of five imported varieties (Halawy, Khadrawy, Deglet Noor, Rhars, and Amhat) were planted beginning in 1940; but the only variety that has matured fruit is the Rhars, which has usually been damaged by rains.

POSSIBILITIES LIMITED

There are more and better imported varieties of dates in Mr. Richardson's experimental planting at Porterville than in any other that has ever been made in California outside the Coachella and Imperial Valleys and they have been given consistently good care. It is clear that commercial plantings of none of these varieties would be justified in that climate, but Mr. Richardson's experience has demonstrated that there are locations in the San Joaquin Valley where the grower who would like to have a few palms to provide fruit for home use can do so if he is willing to take the trouble to learn the cultural techniques necessary to grow the palms and handle the fruit.

Table 1—Climatic Data for Indio and Porterville, California, and Some Other Stations Where Dates Have Been Planted*

		Average Air Temperatures				Average Rainfall						
Station	Latitude	Length of record	Daily maximum May-Oct.	Extreme annual minimum	Length of record	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
		Years	°F	°F	Years	In.	In.	In.	In.	In.	In.	In.
Indio, Calif.	33°43'N.	45	99.9	23.8	73	0.07	0.27	0.30	0.21	0.20	0.58	3.20
Porterville, Calif.	36°04'N.	45	91.1	24.7	62	0.02	0.01	0.13	0.51	0.79	1.66	10.21
Bakersfield, Calif.	35°25'N.	29	91.5	......	56	0.02	0.01	0.11	0.33	0.48	0.88	5.97
Winters, Calif.	38°32'N.	8	89.0	23.3	8	0.01	0.01	0.03	1.07	2.01	3.40	16.09
Riverside, Calif.	33°57'N.	53	87.9	25.8	70	0.01	0.16	0.17	0.61	0.75	1.91	11.19
El Cajon, Calif.	32°47'N.	45	83.6	25.6	54	0.06	0.10	0.20	0.68	1.03	2.34	13.69
Elche, Spain	38°16'N.	6	83.0	37.4	6	0.19	0.44	1.43	2.10	0.30	1.41	12.64

*Data from the U. S. Weather Bureau except for that for Elche, which was obtained by correspondence from the Spanish Ministry of Agriculture.

THE DATE MARKETING ORDER, AN AID TO MARKETING

By Billy J. Peightal

Manager Date Administrative Committee

The Date Marketing Order exists only to provide the industry with a tool to develop orderly marketing. This means that with the Order, the industry is able to market its dates the quality of which is acceptable to consumers, in quantities which are desired, and at a time when they are wanted. The Order, by itself, cannot sell dates, but, when used properly, it will enable sales to be made in an orderly manner which, in the long run, will reflect itself in greater grower returns. It is not a short term expedient—the problems are too complex for this—but in the short time in which it has been operating substantial progress has been made toward the achievement of orderly marketing.

There are two broad provisions in the Order through which orderly marketing may be achieved—through the regulation of the quality and the quantity of dates which are marketed. Relative to the regulation of quality, it first should be mentioned that there are no objective measurements which can be employed to determine exact consumer wants with respect to quality. Over time, however, it has been demonstrated that consumers will not accept low quality products at prices which reflect returns acceptable to growers. On the other hand, quality products move readily into channels of consumption, because the housewife has developed confidence in them. To assure, therefore, that the housewife is offered dates believed to be of a standard sufficient to satisfy her quality specifications, the Committee recommended, and the Secretary established, a grade regulation which requires that all whole and pitted Deglet Noor dates shipped meet the requirements of U. S. Grade C and score at least 31 points for character. The character requirement in effect limits the shipments of dates to those which are U. S. Grade B or Choice. The grade regulation, therefore, satisfies one of the requirements of orderly marketing—that process of marketing dates the quality of which is acceptable to consumers. There is no doubt in the minds of those who market dates that this in time—"in time" is to be emphasized because this is not a short run concept—will return dividends to growers.

The necessity of the other requirements or orderly marketing, that of marketing dates in quantities which are desired and at a time when they are wanted, is more easily explained through the use of statistical tables which tend to illustrate some of the problems faced by the industry and indicates the need of the two attributes. Table 1, reflects the availability and disposition of dates from 1941 through 1955 expressed in terms of five year averages.

Column 1, reflecting beginning carryover on August 1, indicates that the average of the carryovers during the 1951-55 period was more than four (4) times larger than the average of the carryovers experienced during the 1941-45 period. Large carryovers in relation to normal simply means a lower opening price and its relatively rapid deterioration as the new crop becomes available for market. The problem then is to find the means which will prevent the occurrence of excessive carryovers.

Column 2, Field Run Dates Received by Handlers, reveals that production during the 1951-55 period was practically double that of the 1941-45 period.

at prices reflecting reasonable grower returns, or do you try to find new types of markets thereby expanding sales and lessening the pressure to sell dates in the whole and pitted form regardless of price? The latter approach is an absolute necessity.

Table I indicates the problem in a general way. Table 2 reflects the situation of the industry during the past two years.

Beginning the 1955-56 season, the beginning carryover, as shown in Column 1, was small and in this respect the industry was in a relatively healthy position. The production that year, however, was larger than any crop ever recorded and, to further aggravate the marketing picture, it was a late crop. As a consequence of the shortened selling period, Column 4 indicates that only 22.8 million pounds out of the 45.6 million pounds of dates available were sold in the whole or pitted form.

Table 1—Availability and Disposition of Domestic Dates, 1941 Through 1955

	Beginning Carryover August 1	Field Run Dates Received	Total Available	Free Dates Sold	Rest & Products Dates Disposed	Other Disposed	Total Disposed
	1	2	3	4	5	6	7
	million pounds						
1941-45 Avg.	1.2	17.7	18.9	15.1	....	2.6	17.7
1946-50 Avg.	3.0	28.9	31.9	24.1	1.4	2.5	28.0
1951-55 Avg.	4.9	34.8	39.7	26.8	3.6	3.0	33.4

Source: U.S.D.A. and the Date Administrative Committee.

Column 3, Total Dates Available, is simply the summation of Column 1, the beginning carryover, and Column 2, Field Run Dates Received. The data in this column reflects the main problem facing the industry. Comparing the 1951-55 period with the 1941-45 period, indicates that the total amount of dates available for sale has more than doubled. It therefore reveals the main problem largely because over the same period of time the population has not doubled nor has disposable income.

The disparity mentioned above is illustrated to a large degree when Column 4, Free Dates Sold, is compared with Column 3. This comparison indicates that the quantity of free dates sold over the periods under consideration has not increased in the same proportion as has dates available for sale. The question then is what do you do with the excess quantity of dates available? Do you continually attempt to dispose of the excess dates in the whole and pitted market which will not readily absorb them

Column 5 reflects the quantity of marketable dates which were diverted into outlets non-competitive with the whole and pitted market. It should be noticed that the 6.2 million pounds of dates disposed of for products is double the amount so disposed on the average during the 1951-55 period. Thus, from an insignificant beginning, the industry in one year marketed dates in products form in commercial quantities and made tremendous progress toward expanding the date market.

Reflecting the large, late 1955-56 crop and just the beginning of the products program, the industry began the 1956-57 season with a beginning carryover of 12.1 million pounds as indicated in Column 1. In the history of the industry there has never been a carryover as large as this. To compensate for this, however, the production of dates this year appears to be about 10 million pounds less than last year and will approximate 33.8 million pounds. Even with the lighter production,

Table 2—Availability and Disposition of Domestic Dates, 1955-56 Season to Date

	Beginning Carryover August 1	Field Run Dates Received	Total Available	Free Dates Sold	Rest & Products Dates Disposed	Other Disposed	Total Disposed
	1	2	3	4	5	6	7
	million pounds						
1955-56	2.3	43.3	45.6	22.8	6.2	4.5	33.5
1956-57	12.1	33.8	45.9				

Source: Date Administrative Committee.

however, Column 3 reveals that the total quantity of dates available for sale this crop year exceeded last year's total by 300 thousand pounds.

Beginning the 1956-57 season, then, the industry was faced with the gigantic problem of marketing 46 million pounds of dates in, broadly speaking, two major outlets. One outlet, the market for whole and pitted dates, is termed the "free date outlet," and the other outlet, termed the "restricted outlet," is the market for dates to be sold in a products form.

Both outlets have limits as to the quantity of dates which they can absorb at prices reflecting reasonable returns to growers. The free date outlet, however, presently appears to be the most flexible in that a considerable quantity of dates can be moved in this channel, although grower returns will vary inversely in varying degrees with the quantity of dates so moved. This channel, however, is where most money will be obtained and, therefore, it is here where it is necessary to eliminate the pressure to dump dates regardless of price. It is this channel from which price stability will come, but it will only come when the quantity of dates available to this outlet is not in excess of what the trade will accept at reasonable prices.

In an effort to relieve the pressure to dump dates in the free date outlet, knowing that 46 million pounds of dates would be available and knowing that reasonable price levels will be attained only when the quantity of dates available to the free date outlet is not excessive, the Committee established a restricted percentage requiring a considerable quantity of dates to be disposed of in the restricted outlet. Through this procedure then, the establishment of the free and restricted percentages thereby allocating the crop among outlets, dates are marketed in quantities desired which satisfies another of the requirements of orderly marketing. Experience the past two years, however, has shown that allocating the crop among outlets has not in itself completely satisfied the remaining requirement that dates be offered at a time when they are wanted. In other words, the Order can regulate the quantity of dates available for sale in the whole and pitted form in a season, but at any given time during a season there may be dates available that can be offered in quantities which at that time are in excess of what the trade will accept at reasonable prices.

Now, a word about the restricted outlet. This outlet, the market for dates to be manufactured into products, has been available on a commercial level only for the past two years and, consequently, the quantity of dates that now can be moved in this channel definitely is limited. In time, however, this outlet of necessity will have to absorb the over production with the quantity of dates made available to the free date outlet kept at a uniform level and allowed to increase over time only as demand increases. As of now, however, and until there is more development of markets for date products, which does take considerable time, an excess quantity of dates in the restricted outlet simply cannot be moved. Therefore, the proper allocation of dates between the free and restricted outlets falls short of requirements with respect to completely eliminating excesses in the free date outlet. The fact remains, however, that as long as there is an apparent quantity of dates available for sale in the whole and pitted form in excess of that which will reflect reasonable grower returns, the industry must make the transition from selling dates in only the one outlet to selling dates in the two outlets.

In order to ease the pains of transition and also to encourage the development of date products and the market for date products, the Committee again requested the Secretary of Agriculture for a date diversion program. The Committee's request was granted, and a program was established paying four (4) cents a pound, one (1) cent more than last year, for all Grade C or better Deglet Noor dates converted into approved products. The latest figures available indicate that more than 11 million pounds have been approved for diversion payments which will mean that almost a half a million dollars will come to the industry this year through the diversion program.

At this point it would seem well to illustrate the manner in which the Committee determines the levels of the free and restricted percentages. This is shown in Table 3. The data pertains only to Deglet Noor dates and is the same as that presented the Committee last June when the percentages were calculated. Item 1 was the total estimated production of Deglet Noors and it now appears the actual production will exceed the estimate by only 700,000 pounds. Item 2 reflects that portion of the production which the Committee estimated would be of marketable quality. Items 4 and 6 respectively represent estimated handler's carryover of marketable dates on August 1, 1957, and the Committee's estimate of desirable carryover on August 1, 1958. Although based on reports from all handlers, you will notice that all of the data is estimated. This is necessary because the determination for the crop year beginning August 1 is made in June, and it does make the task a difficult one. The most difficult problem of all, however, is the estimate of trade demand, Item 7, largely because of the lack of factual data relating to sales in previous years. As more data becomes available, the estimate will be made on a stronger basis than is now possible. The Committee now, however, estimates the trade demand to approximately 24 million pounds.

Items 9 and 10 indicate the methods of calculating the free and restricted percentages. It is apparent that the percentages are determined solely by the relationship of marketable dates available and the trade demand.

Table 3—Calculation of the Free and Restricted Percentages, Deglet Noor Dates, 1956-57 Season

Item	Million Pounds
1. Estimated Total Production	31.2
2. Estimated Marketable Production	27.5
3. Handler's Marketable Carryover 8-1-56	8.5
4. Total Marketable Available (Item 2 + Item 3)	36.0
5. Less: Desirable Marketable Carryover 8-1-57	4.0
6. Net Marketable Available	32.0
7. Less: Trade Demand (free dates)	24.0
8. Restricted Dates	8.0
9. Free Percentage (Item 7 + Item 6 × 100)	75%
10. Restricted Percentage (100% less Item 9)	25%

Not all of the aids to marketing are derived from the regulatory provisions of the Order, because the Committee can, and does, sponsor research projects in the area of marketing. At the present time, it has several projects going forward some of which will be completed in the near future while others will not be completed for some time.

One major project of the Committee is that of determining the chemical causes of quality deterioration and darkening of dates over time. It is doing this through the research chemist it has hired who uses the facilities of the U. S. Department of Agriculture's Western Utilization Research Laboratory. This work, the chemical approach to the problem, supplements the splendid work Dr. Rygg now is doing. On completion of the chemical phase of this research, the combined findings will be used to correct the disorder. The results will be long life dates of high quality which then will reduce retailer losses, which is extremely important to good marketing, assure consumers of quality fruit regardless of when packed, and perhaps reduce storage costs.

Another major research project of the Committee designed to better the quality of packed dates and also to reduce packing costs, is the development of an electronic device which will sort dates according to moisture content. The Committee has stressed the need of this to the Department of Agriculture for the past two years, and, at this time, the contract for the work is being let to an electronic research firm. The initial cost of this project will amount to upwards to $32,000 all of which is being borne by the Department.

In its efforts to obtain information for the industry which it can use to strengthen over all marketing practices and promotion programs, the Committee requested the U. S. Department of Agriculture to conduct a nation-wide survey to determine the housewife's uses, attitudes and opinions of dates. The housewife's thinking relative to dates, of course, should be the basis of future research and action programs. Urged by the Committee of the importance of such a study to the industry's marketing program, the Department now is conducting the survey and results soon should be available.

Also, at the present time, the Department, at the request of the Committee, is conducting retail market tests in the Boston Area to determine consumer preferences and response with respect to various sized date packages. If significant preference differences occur, the Committee will request additional tests in other areas to ascertain national preferences. It may well be that these tests will indicate a need to simplify packaging practices with resultant savings in packaging costs.

Another project now under way is the development of a systematic formulated method of estimating the size of the crop prior to picking. This work is being undertaken upon the request of the Committee by the Extension Service of the University of California. With the lack of uniform data available with respect to factors affecting yield, it is believed the project will take about three years to complete. However, when a method is developed, those charged with the responsibility of marketing the crop will be able better to plan their marketing operations and thereby eliminate some of the guess work with which they now must cope. This, of course, will lead to sounder marketing.

The latest project about to begin under the auspices of the Department, is one designed to measure the efficiency of currently used work methods and equipment relative to receiving, sorting, handling, and packing dates. Should this study initiate savings in packing operations through better work methods and more efficient equipment, they largely will find their way to growers.

As you can see, the promotion of and participation in research activities directed toward improving the date marketing structure for the benefit of the industry is a major function of the Committee operating under the Order. There has been substantial success in initiating the projects and, as results are obtained, the findings will be given the industry for its betterment.

TWENTY YEAR BUNCH PRODUCTION RECORD OF INDIVIDUAL DEGLET NOOR DATE PALMS

By T. R. Brown

Thermal Date Grower

The report is based upon figures Mrs. Brown began recording in 1933 as a hobby when our first date planting was made. She has annually recorded the offshoots and the fruit bunches the trees have produced and has made observations on the condition of the trees. The record extends over a 24 year period and your program committee thought it would be of interest to the group.

The date garden is located at the intersection of Highway 99, Avenue 70 and Polk Street. The soil is classified as Coachella very fine sand and seems suitable for the Deglet Noor variety of date to which this report is confined. The bunch count was made in the fall and included only matured bunches. The planting we will discuss consists of 231 Deglet Noor trees planted in 1933 and 204 trees planted in 1934. The first planting consisted of large offshoots and the second one of vigorous nursery trees so they are treated as one, since little difference in tree size or bearing ability has been noted after the first few years.

Production figures used are based upon packing house weight slips after shrinkage has been deducted. Packing house culls are included but field cull tonnage is not, as culls were gathered only during a three year period. This probably makes the weight per bunch and tree conservative, but gives us weights useful in figuring returns.

The production figures are given for 21 years and then broken into two periods—the first 11 years 1934—1946, and the second 10 years 1947—1956. This grouping gives a production figure as the trees develop, and another after they mature. The period grouping was also used to see if a change in bunch thinning in 1946 might be observed. In that year we began leaving all but a few of the late, weak bunches. Prior to 1946 we had thinned to 15 or less bunches per palm, depending upon the size and vigor of the tree. We compensated for the increased bunches by strand thinning 25 to 30 instead of 30 to 35. We believed that dates, like other fruit crops, must depend on quality if the grower and the industry are to prosper. No other fresh or dried fruit can compete for the shopper's dollar unless it is of first quality, and a product as full of calories as a date must really appeal to the shopper to be carried home. With this in mind, we have always given the garden what we considered adequate fertilizer and water and have thinned severely. Both quality and quantity are controlled to a considerable degree by the weather, so that

poor crops are sometimes produced regardless of efforts.

The erratic production of the last ten years could be due, in part, to the fruiting of most of the date bunches. The garden produced 17,-892 pounds per acre in 1951, but only 8,653 pounds in 1952. The average production for the last ten years was 13,493 pounds. It is interesting to note that there were 1,773 more bunches in 1955 than 1956, but three pounds less fruit. This was probably due to less strand thinning in 1956 to compensate for the loss of bunches, and by the fact that there was little shatter during this last picking season.

One obvious fact we have observed that will not be shown on the charts to follow, is that replants do not pay. Three inside replants have averaged only 6.2 bunches per year the last ten years. One on the south outside row has done well and averaged 11.2 for the same period. These few trees have, however, been included with the other figures as they probably represent a typical garden. Replants should be made early and with trees that will maintain an even height with the others.

The following charts will probably show the twenty-four year history of the garden more clearly than any other way.

SUMMARY

This report is a brief summary of twenty-four years of records of date production and bunch counts, together with a record of offshoots produced, kept by Mrs. Brown as a hobby. The report deals only with the original planting of 435 Deglet Noor palms.

Records show that outside rows exposed to more sunshine than those inside consistently bear the heaviest crops. This fact is also observed in the records of inside trees that surround a small replant.

Deglet Noor date palms are considered mature at eight years by the county assessor for tax purposes but our palms do not seem to reach maturity until they are thirteen years old.

Total tonnage and individual bunch weight vary considerably when fruit bunches are not reduced by thinning. Fruit quality seems to be improved by leaving most bunches and compensating by heavy strand thinning.

Little or no effect on fruit production can be found by producing a normal crop of offshoots.

High quality fruit, together with high production, is essential both to the industry and the individual grower if they are to prosper.

Table 1

1934—1956

Number of trees	435
Number of bunches	114,214
Pounds produced	1,920,360
Average weight per bunch	16.81 lb.
Bunches per tree (21 years)	262.53
Bunches per tree (1 yr. avg.)	12.5
Pounds per tree (21 yrs.)	4,413.13
Pounds per tree (1 yr. avg.)	210.13

The above figures represent all crops produced.

Table 2—Effect of tree location in number of bunches produced

	21 years	1 year	lbs. per year
Average number of bunches per tree (all)	262.53	12.5	210.12
Average South row (outside)	295.00	14.0	235.34
Average East row (outside)	319.00	15.2	255.51
Average Middle row—South to North	265.1	12.6	211.8
Average Middle row—East to West	294.9	14.0	235.34
1947—1956 — Second 10 year period			
Average number bunches per tree (all)	156.5	15.0	263.08
Average South row (outside)	186.3	18.0	313.17
Average East row (outside)	188.9	18.0	317.54
Average Middle row—South to North	160.4	16.0	269.63
Average Middle row—East to West	163.6	16.0	275.01

The duplication of tables for the second period is to show production of mature palms as the first table gives the average of all production. The above figures would indicate that palms need more sunshine than the standard planting of 30x30 feet.

Table 3—Annual Production

	Total Bunches	Total Pounds	Pounds per Bunch
1936	767	8,282	10.79
1937	1,560	15.771	10.10
1938	1,648	14,029	8.51
1939	3,223	22,817	7.07*
1940	3,489	55,612	16.31
1941	4,921	74,542	15.14
1942	4,555	79,321	17.14
1943	6,015	131,853	21.92
1944	6,133	124,651	20.32
1945	6,297	42,208	6.70*
1946	6,809	146,782	21.60
1947	5,575	106,220	19.05
1948	7,626	138,000	18.10
1949	6,655	114,200	17.13
1950	6,828	129,139	18.91
1951	7,613	161,029	21.15
1952	6,581	77,879	11.83
1953	7,850	116,541	14.85
1954	5,356	85,891	16.04
1955	7,992	127,764	15.97
1956	6,219	127,767	20.54

*Matured bunches were small in 1939 because of a severe freeze the preceeding year. Rains and heavy humidity in 1945 ruined most of the crop.

Figures from this table would indicate that Deglet Noor palms do not reach maturity until they are thirteen years old.

Table 4—Effect of Offshoots on Number of Bunches Produced

	1st 10 years	2nd 10 years	21 years
Total Bunches per tree (all trees)	106.0	156.53	262.53
Bunches per tree (20 trees with most offshoots)	111.7	160.6	272.3
Bunches per tree (20 trees with no offshoots)	116.0	159.9	275.9

The above figures would indicate there is little effect of offshoots upon production. However, offshoots were reduced to approximately eight per tree on any trees producing more than that number.

Table 5—Grade out of our fruit compared with packing house average and another garden below the packing house average, together with per pound returns, 1955-1956 crop.

Grade	Brown	Packing house Average	X	Returns per pound
Commercial	16.75%	9.8%	3.7%	$0.121
Standard	18.51	18.1	13.3	.0778
No. 1 Dry	31.88	23.7	22.1	.0871
No. 2 Dry	22.63	32.7	42.1	.0572
Substandard	4.00	7.8	10.3	.03
Culls	6.4	7.9	8.5	.00

The better fruit returns the most money. The above figures are given to show that the best cultural practices are necessary if a date garden is to be operated profitably.

Table 6—Returns per acre from our 1955-56 crop of 14,335 pounds per acre compared with returns based on the same tonnage but with the average packing house grade out and with that of X's garden given in table 5.

Grade	¢ per pound	Brown	Packing house	X garden
Commercial	$0.121	$ 289.67	$ 170.01	$ 64.13
Standard	.0778	206.32	201.89	148.36
No. 1 Dry	.0871	397.08	295.88	275.93
No. 2 Dry	.0572	185.32	268.15	345.20
Substandard	.03	17.19	33.54	44.31
Culls (packing house)	.00	.00	.00	.00
Totals		1,095.58	969.47	877.93
Difference			126.11	217.65
Average returns per pound		.0765	.0676	.0612

The above figures show that a date crop must reflect both quantity and quality if returns are to show a net profit over operations.

EFFECT OF AGE AND NUMBER OF LEAVES ON FRUIT PRODUCTION OF THE DATE PALM

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The importance of number of leaves in fruit production of the date palm has been emphasized in previous reports, but relatively few data dealing with the relation of age of leaves to yield have been reported. The two factors are actually inseparable because the nature of their growth is such that no two leaves on a date palm are exactly the same age. This paper is a brief summary of four experiments which have not been previously covered except for brief references to two of them in reports on other studies (1, 2, 3). In two of the experiments an attempt was made to evaluate age as well as number of leaves. In another the emphasis was on number of leaves per bunch in relation to yield over a period of years. The fourth experiment was a study of the relation of position of leaves to fruit production, which is important because the oldest date leaves are the lowest in the crown and the farthest removed from the zone from which the fruitstalks emerge. The data presented provide a better understanding of some of the factors involved in leaf pruning and fruit thinning, cultural practices by which the grower exercises some control over age and number of leaves in relation to fruit production.

A COMPARISON OF THE EFFICIENCY OF ONE AND TWO YEAR OLD LEAVES

Experimental Procedure

The efficiency in fruit production of leaves up to one year old was compared with that of leaves one to two years old in an experiment carried out in 1939 with 48 Deglet Noor palms, 9 years old, in a garden about 4 miles west of Indio. On May 25 to 27 the number of leaves on all palms was reduced to 30, which records indicate is about the maximum number produced in one year. On half of the palms the 30 youngest leaves (those produced in 1938) were retained and on the other palms the next 30 below (those produced in 1937) were retained. The leaves emerging subsequently in 1939 were retained on all palms. Each palm with 1-year leaves was paired with a palm with 2-year leaves.

Pollination and fruit thinning were uniform on all palms. Pollen from only one male was used and all bunches were thinned by cutting back the tips of the strands at pollination and later by removing entire strands from the centers of the bunches. After final thinning all bunches carried approximately 1000 dates. At the second thinning 6 different treatments were initiated by varying the number of bunches on different pairs of palms to 2, 3, 4, 5, and 10 per palm, which provided leaf-bunch ratios of 15, 10, 7.5, 6, and 3.

Results

The size of leaves on each palm was estimated from measurements of 2 typical leaves of the 1-year and 2-year groups and 1 of the new leaves that emerged after the beginning of the experiment. There were no significant differences in size (leaflet area—one surface only) between the 1-year leaves (average 20.8 sq. ft.) and the 2-year leaves (average 20.1 sq. ft.). However, leaves produced in 1939 after the initiation of the experiment were smaller regardless of treatment, but the size of those produced on palms with 1-year leaves (average 18.9 sq. ft.) was not significantly different from that of those produced on palms with 2-year leaves (average 17.8 sq. ft.).

Average daily leaf elongation, determined from weekly records for 17 weeks ending October 5, was about 4.5 cm. per day in all treatments except the lowest ratio of 3 leaves per bunch in which there was a significant reduction to about 3.8 cm. per day. There were no consistent differences in leaf elongation between palms with 1-year leaves and those with 2-year leaves.

From records of fruit on typical strands on each bunch there appeared no significant differences between treatments as to fruit drop, shrivel, checking, or blacknose. Ripening was slightly delayed when there were only 3 leaves per bunch. Samples taken at monthly intervals began early in the season to show higher weight per fruit, both fresh and dry, from palms with 1-year leaves than from palms with 2-year leaves. Fresh weight per fruit, dry weight of flesh and fresh weight of seed as determined from samples at time of harvest are shown in Figure 1. When the number of leaves per bunch was increased from 3 to 15, size of fruit reached a peak at about 10 leaves per bunch, although differences were small or lacking for some measurements between successive ratios above 6 leaves per bunch. There was no effect of leaf-bunch ratio on the weight of the seed. Fruit samples from two of the treatments (3 and 10 leaves per bunch) were used in a separate study by Rygg (4) who reported similar differences in dry weight of fruit.

Fruit from the different treatments was graded in a commercial packing house; the results are given in Table 1.

The percentage of fruit in grades 1 and 2 was lowest with the lowest leaf/bunch ratio, 3, in which treatment a much lower percentage was obtained from the two year leaves than from the one year leaves. Some differences in the same direction were apparent with increasing leaf/bunch ratios up to 10 but without replications their significance cannot be determined. Since size is given some weight in commercial grading, it is of interest to recall that the largest fruit was also obtained with a leaf/bunch ratio of 10.

Table 1—Effect of Leaf/Bunch Ratio and Age of Leaves on Grade of Deglet Noor Fruit

Age of leaves (period when produced prior to experiment)	3	6	7.5	10	15
	Fruit in grades 1 and 2 (percent) from palms with indicated number of leaves per bunch				
1st year	35	54	59	72	40
2nd year	6	46	42	51	47

Rains occurring early in September caused an estimated loss of about 60 percent of the crop, made it impracticable to obtain individual palm yields, and complicated the grading of fruit. On the basis of field observations there seemed to be a higher percentage of rain damage as the leaf/bunch ratio was increased and this may have had some bearing on the somewhat lower grades obtained from 15 leaves per bunch than from 10 leaves per bunch, especially with the one-year leaves. In any event, the small crop resulting from only 2 bunches per palm would have tended to magnify chance differences.

Table 2.—Effect of Age of Leaves and Leaf/Bunch Ratio One Year on Number of Inflorescences and Size of Fruitstalks the Following Year on Deglet Noor Palms

Leaf/bunch ratio 1st year	3	6	7.5	10	15	Average of all
Average number of inflorescences per palm 2nd year						
1-yr. leaves	11.3	12.8	13.5	14.5	14.8	13.4
2-yr. leaves	8.5	12.8	12.5	13.2	14.5	12.3
Average cross-sectional area of fruitstalks 2nd year (sq. cm.)						
1-yr. leaves	6.7	8.0	8.1	9.0	8.8	8.1
2-yr. leaves	5.4	7.5	7.5	8.2	8.1	7.3

A further comparison was obtained the following year when more inflorescences and larger fruitstalks were produced on palms with one-year leaves than on those with two-year leaves (Table 2). Differences are small or lacking within some leaf/bunch ratios, but when all the palms with leaves of the same age are grouped throughout the series, the average differences between one and two year leaves become statistically significant.

CUMULATIVE EFFECT OF DIFFERENT LEAF/BUNCH RATIOS AND LEVELS OF THINNING

A five-year study of the cumulative effect of different leaf/bunch ratios has already been partially and briefly summarized (3). Sixty Deglet Noor palms, 7 years old at the start, were used in this experiment conducted in cooperation with Mr. D. H. Mitchell and the Coachella Valley Fruit Co. By removing bunches the number per palm was varied so as to obtain six different treatments: 11, 9, 7.5 and 6 leaves per bunch with moderate fruit thinning of the bunch and 7.5 and 6 leaves per bunch with heavy fruit thinning. The first two (11 and 9) were the only ratios that could be carried continuously throughout the 5 years because of a definite tendency for high yields resulting from low leaf/bunch ratios one year to reduce the number of inflorescences and yields the following year, when, of course, the crop was necessarily carried with higher leaf/bunch ratios. A leaf/bunch ratio of 6 caused such a pronounced reduction in the number and size of inflorescences after two years that it was subsequently raised to 13. As a consequence of these fluctuations the five-year totals for the 6 treatments did not show striking differences as to either yield or grade. The highest total yield (8088 lbs.) for the 5 years was obtained with moderate thinning and a leaf/bunch ratio of 7.5 carried for 3 years and 11 for 2 years, but this was not significantly different from the next highest total yield (7894 lbs.) obtained with moderate thinning and a leaf/bunch ratio of 9 carried for the entire 5 years. However the results suggest that between these two treatments the maximum bearing capacity of the palm was reached. Heavy thinning increased size of fruit but decreased total yield and increased the percentage of blacknose in years when this disorder occurred. The data appear to justify the conclusion that over a period of years it is to the advantage of the grower to use a leaf/bunch ratio that will utilize the full productive capacity of the palm but not cause serious alternate bearing.

COMMERCIAL PRUNING VERSUS REMOVING NEW LEAVES

Experimental Procedure

The removal of all but 30 leaves in the first experiment reported was so drastic that it seemed desirable to have one in which the commercial range of pruning would be included. Such an experiment was begun with 48 Deglet Noor palms, 12 years old, at the U. S. Date Field Station in the spring of 1946. The palms were scattered in a block being used for an irrigation experiment and varied somewhat in size, vigor, and growing conditions, but they were arranged in 12 groups of 4 palms each selected so that there would be a minimum of variation within the group. The leaves varied in size from about 19 to 23 sq. ft. (leaflet area — one surface only). The average number of leaves on these palms was about 150; this represented approximately 6 years' growth as in previous studies Deglet Noor palms of this age under similar conditions produced about 25 leaves per year.

Four different leaf pruning treatments were given to palms selected at random within each group: in 3 of them the oldest (lowest) leaves were removed until there were left 100 (A), 125 (B) and 150(C) leaves per palm; but in the fourth treatment (D) the 50 youngest (highest) leaves were removed and the 100 oldest (lowest) leaves retained. At the beginning of the experiment a few of the palms in Treatment C did not have quite as many leaves as desired and there was no pruning in this treatment the first year, but this was not the case later and the average number of leaves per palm in all treatments was very close to the desired number throughout the experiment. The palms were pruned on March 8, 1946, May 19, 1947, and June 18, 1948; all leaves produced after those dates were left until the following year. The ages of the leaves retained in the different treatments were approximately as follows: 1-4 years in Treatment A; 1-5 years in Treatment B; 1-6 years in Treatment C; 3-6 years in Treatment D. Since no subsequent pruning was given in Treatment D, the original number of leaves was increased by the new growth so that it had young leaves up to 1 year old in 1947 and up to 2 years old in 1948; also the original leaves were older each year, representing 4-7 years in 1947 and 5-8 years in 1948, but most of the old leaves were dead before reaching the end of the 8th year; the average number per palm after pruning the 3rd year was 141. As many bunches as possible were left on all palms; this was usually 2 or 3 less than the number of inflorescences produced in any of the treatments.

Results

The effects of removing all leaves not over 2 years old began to show up by midsummer of the first season. On 14 of the smaller and later bunches all the fruit shrivelled prematurely and was a total loss. The yield of fruit harvested was greatly reduced and this was accompanied by a reduction in grade and weight per fruit, both fresh and dry (Table 3). Even the weight per seed was less than in any of the other treatments. The fruit was also later in ripening as shown by the reduced percentage of the crop in the first picking in both 1946 and 1947. The effect of the removal of the younger leaves carried over into the third year of the experiment as shown by the reduced number of inflorescences and lower yields in both 1947 and 1948, in spite of an increasing leaf/bunch ratio. (Number of inflorescences and yields were the only two effects measured the third year.) On the other hand there were no pronounced differences in yield, grade, or size of fruit, among treatments A, B, and C in which the palms were pruned to 100, 125, and 150 leaves by removing the older ones from below. The grade and dry weight of fruit were lower the first year in Treatment A than in Treatments B and C, but these differences were not significant and were still less the second year. However, this suggestion of a trend points to the possibility of a slight advantage in grade and size of fruit from retention of leaves in excess of 100 per palm. In pruning experiments previously reported (3) the 5-year total yield of palms pruned yearly to about 100 of the youngest leaves was not significantly different from that of palms allowed to retain all the leaves they would carry (maxima of 150 to 180), but the results suggested that higher

Table 3—Effect of Age and Number of Leaves on Flowering and Fruit Production of Deglet Noor Date Palms

Effect measured	Year	Pruning treatment and No. leaves per palm*			
		A	B	C	D
		100	125	150	100
Total inflorescences (number)	1946	152	155	147	146
Total inflorescences (number)	1947	113	123	113	97
Total inflorescences (number)	1948	152	152	150	130
Fruit in 1st picking (percent)	1946	44.4	47.7	42.4	31.3
Fruit in 1st picking (percent)	1947	48.0	53.2	52.0	39.2
Fruit in grades 1 and 2 (percent)	1946	39.7	45.4	46.4	34.0
Fruit in grades 1 and 2 (percent)	1947	37.5	38.0	39.4	40.5
Average yield per palm (pounds)	1946	309	293	289	230
Average yield per palm (pounds)	1947	215	213	201	146
Average yield per palm (pounds)	1948	250	263	246	215
Average fresh weight per fruit (grams)	1946	8.6	8.7	9.1	8.0
Average fresh weight per fruit (grams)	1947	7.9	8.1	8.1	8.3
Average dry weight of flesh per fruit (grams)	1946	6.1	6.8	8.5	5.8
Average dry weight of flesh per fruit (grams)	1947	5.9	6.2	6.2	6.4
Average weight per seed (grams)	1946	0.82	0.82	0.81	0.64
Average weight per seed (grams)	1947	0.72	0.73	0.73	0.69

*Yearly pruning with youngest leaves retained except in treatment D, in which the 50 youngest leaves were removed with no further pruning during the experiment except the removal of dead leaves.

yields might have been obtained by pruning yearly to about 120 leaves per palm.

The differences in number of leaves per palm the first year resulted in leaf-bunch ratios ranging from 7.8 with 100 leaves per palm to 12.1 with 150 leaves per palm, but in spite of that there was an almost uniform reduction in the yields of all treatments the second year. Either the annual bearing capacity of all palms was exceeded the first year or some unknown limiting factor or factors were involved. This was also suggested by the fact that in spite of an increase in leaf/bunch ratios in all treatments the second year, the weight per fruit, both fresh and dry was less than the first year in all treatments except the one in which the young leaves had been removed. That the total yield per palm the second year was not in excess of its capacity is indicated by the increase in number of inflorescences and yield the third year.

The detrimental effects of removing young leaves up to two years of age contrasted with the absence of significant differences among treatments in which they were retained and the total number of leaves per palm increased by the retention of varying numbers of the older leaves are evidence of the higher efficiency of the younger leaves.

EFFECT OF POSITION OF LEAVES ON DRY WEIGHT OF FRUIT

Experimental Procedure

In 1955 tests were made with 12-year old palms of the Barhee variety to determine the effect of position of leaves on fruit development. On June 16 and 17 each of 12 palms was pruned so as to leave only 40 of the youngest leaves, all on one side. On 6 of these palms all the fruit bunches (10-15) were retained; on each of the other 6 palms only 4 bunches were left, 2 on the pruned side and 2 on the unpruned side. In another test, on each of 7 Barhee palms of the same age the subtending and adjacent leaves (5-7) were removed from around 1 fruitstalk, all bunches (10 - 15) being retained. When fruit was ripe 2 samples of 100 dates were taken from each palm —1 from bunches whose fruitstalks emerged from the trunk in the center of the area where leaves had been removed and 1 from comparable bunches on the opposite side where no pruning had been done. The dates were cut, the seeds removed, and both flesh and seeds were spread out on shallow wire-bottom trays and dried until there was slight further loss of weight.

Results

The average air-dry weights of flesh per fruit on the palms with half the leaves removed were: with 4 bunches per palm, 10.6 grams on the side with leaves, 10.0 grams on the side without leaves; with all bunches retained, 10.0 grams on the side with leaves, 9.4 grams on the side without leaves. The average air-dry weights of flesh per fruit on the palms in the other test were 9.1 grams from fruitstalks with subtending and adjacent leaves present and 8.5 grams from fruitstalks with subtending and adjacent leaves removed. These are significant differences.

In each of the 3 groups of palms the dry weight of flesh per fruit was lower when the leaves subtending and adjacent to the fruitstalks were removed. The differences were of about the same magnitude whether only a few leaves in the vicinity of the fruitstalk or all the leaves on one side of the palm were removed, although the distance from the base of the fruitstalk to the nearest green leaves was much less in the former treatment than in the latter.

The average air-dry weights of seed per fruit in these tests were: from the 12 palms on which half of the leaves were removed, .71 gram on the side with leaves and .67 gram on the side without leaves; from the 7 palms on which leaves subtending and adjacent to 1 fruitstalk were removed, .76 gram with nearest leaves retained, .73 gram with nearest leaves removed. These differences were not significant but as they are correlated with significant differences in the air-dry weight of fruit, they suggest the probability of significance with a larger number of replications.

The paramount importance in fruit production of the leaves subtending and adjacent to the fruitstalks is clearly indicated. In these tests age of leaves was not a factor, but there is little reason to doubt that after the first year the value of the older leaves is lowered because their distance from the fruitstalks increases with age.

DISCUSSION AND CONCLUSIONS

Data from the field experiments that have been presented lead to the conclusion that after the first year the value of date leaves for fruit production and palm growth gradually declines. These results have recently been confirmed by other tests (4). Through the collaboration of Dr. R. T. Wedding of the Citrus Experiment Station, direct determinations of the photosynthetic efficiency of leaf tissue of different ages were made with a Warburg respirometer which provides an index to photosynthesis by measuring the oxygen given off by detached portions of leaves under uniformly controlled conditions of light and temperature. The findings were further confirmed by the percentage increase in dry weight of leaf tissue on the palm during the day as determined by the so-called "half-leaf method." In both these tests the photosynthetic efficiency of date leaves declined after the first year so that leaves 4 years old were only about 65 percent as efficient per unit of leaf area as those one year old.

Actually the efficiency of the older leaves in fruit production is probably somewhat less than these recent tests indicate. Data have been reported showing that the proximity of the leaf to the fruitstalk is important and the older leaves would undoubtedly be somewhat less valuable for fruit production than the younger leaves because they are more distant from the point where the fruitstalks emerge from the trunk. Furthermore the

oldest leaves on a date palm are always the lowest and consequently are more shaded than the upper and younger leaves and this shade may serve to reduce still further the efficiency of photosynthesis.

Since no two leaves on a date palm are the same age, it is apparent that it is not possible with our present knowledge to formulate exact leaf/fruit or leaf/bunch ratios. Nevertheless, within the framework of uniform leaf pruning, fruit thinning and other cultural practices, leaf/bunch ratios may be useful in estimating the crop that a palm should carry. The size and number of leaves that a palm produces are a reliable index of its productive capacity. There is increasing evidence that by applying all available cultural knowledge a near approach to uniformity of maximum annual production can be achieved without sacrifice of either quantity or quality of fruit.

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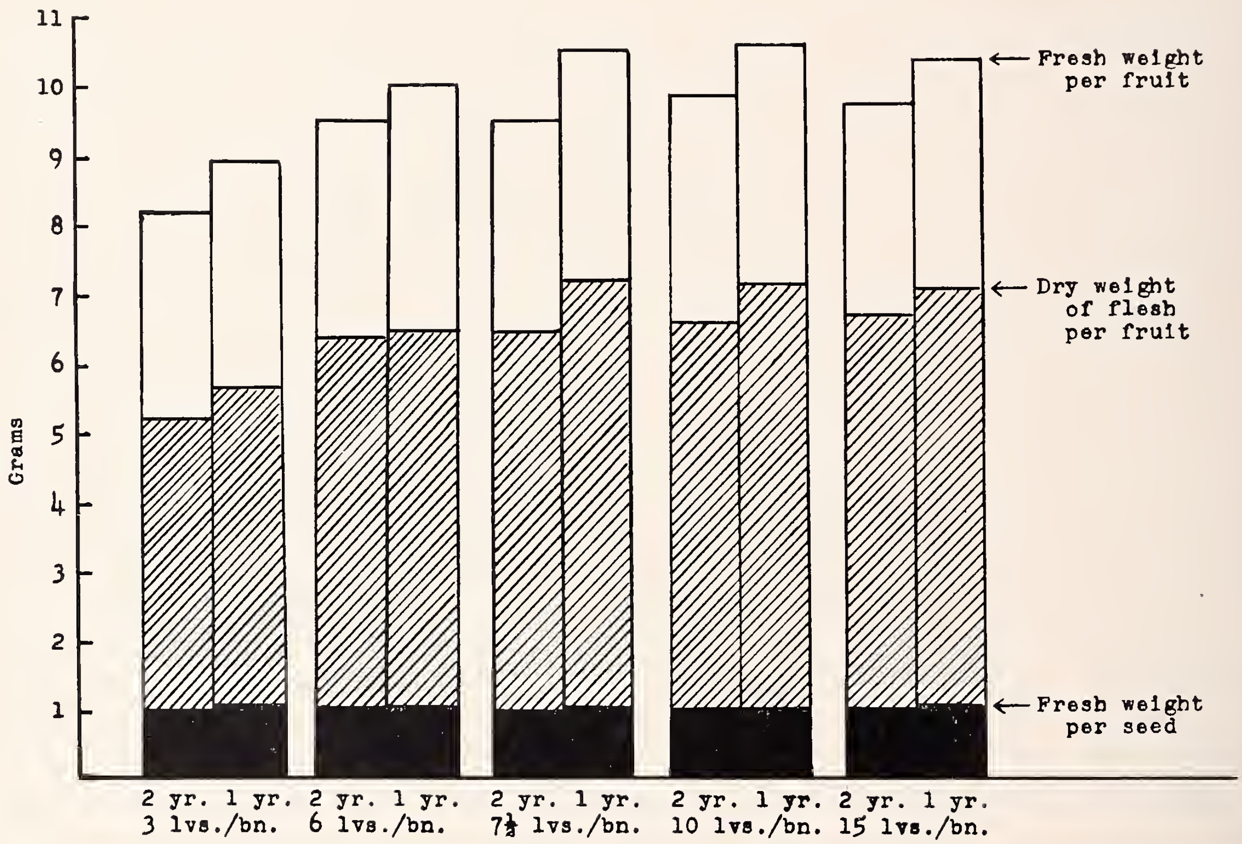

Fig. 1. Effect of age of leaves and leaf/bunch ratio on weight of fruit and seed

Date Growers' Institute - 1957 Membership

(As of August 31, 1957)

Anderson, Mrs. Lee . . . . . . Coachella
Arkell Date Garden . . . . Indio
Asker, Earl . . . . Indio

Benninghoff, Howard . . . . Thermal
Blackburn, R. W. . . . . Thermal
Breyer, Alberto . . Buenos Aires, Argentina
Brown, Thos. R. . . . . Thermal
Burnham, Roderick . . . . . Palm Springs

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Codekas, Jerry . . . . Thermal
Cook, Robert E. . . . . Indio
Cook, W. W. . . . . Palm Desert
Cosgrove, Robert S. . . . . Indio
Crommelin, Mrs. J. B. . . . . . Palm Springs
Cruess, W. V. . . . . Berkeley

Darley, E. F. . . . . Riverside
Darnell, W. G. . . . . Brawley
Dates Officer . . . Berbera, Somaliland Pro.
Da Vall Date Gardens . . . Cathedral City
Dillman, R. S. . . . . Winterhaven
Downing, A. P. . . . . . Brewton, Alabama

Echols Ranch . . . . Thermal
El Fawal, Ahmed Nagiub . Damarhoor, Egypt
Embleton, Tom W. . . . . Riverside

Farrar, E. Keith . . . . Indio
Furr, J. R. . . . . Indio

Gandra, Heloisa . . . . . Sao Paulo, Brazil
Gandra, Sidney O. . . . . Sao Paulo, Brazil

Halsey, Dean . . . . Indio
Heiny Nursery . . . . Brawley
Henderson, Randall . . . . . . Palm Desert
Hilgeman, R. H. . . . . Tempe, Arizona

Jaleto Ranch (H. J. Norris) . . . Los Angeles
Jarvis, Eugene . . . . Thermal
Jenkins, Paul . . . . Indio
Jenkins, W. G. . . . . Indio
Johnson, Mrs. May . . . . . Winterhaven

Kral, Louis . . . . Calexico

Laflin, Ben, Jr. . . . . Thermal
Laflin, Ben, Sr. . . . . Thermal
Leach, George . . . . Thermal
Lichty, Kenneth . . . . Indio
Lindgren, D. L. . . . . Riverside
Martin, Martha Reid . . . . Rancho Mirage
Mitchell, Don . . . . Indio
Mock, D. C. . . . . Redlands
Mrak, E. M. . . . . Davis

Nixon, Roy . . . . Indio
Noland, Warren . . . . Los Angeles

Patterson, Kenneth . . . . . . Coachella
Peightal, B. J. . . . . Indio
Pinyan, R. A. . . . . Indio
Puls, J. H. . . . . Pasadena

Reid, Robert H. . . . . Chicago
Reuther, Walter . . . . Riverside
Richardson, H. B. . . . . Davis
Riverside Co. Agri. Com. . . . . Riverside
R R J Ranch . . . . Indio
Russel, Robbins . . . . Redlands
Rygg, G. L. . . . . Pomona

Scheniman Paper Co. . . . . Indio
Schroeder, C. A. . . . . Los Angeles
Schwabacher, A. E. . . . . San Francisco
Shields, Floyd . . . . Indio
Swingle, Leonhardt . . . . Indio
Swingle, Mrs. Walter T. . . Washington, D. C.

Turk, Howard . . . . Coachella

Urich-Codekas Date Ass'n . . . . . Thermal

Venus Foods . . . . Los Angeles
Vincent, Lloyd . . . . Riverside

Wallace, Earl . . . . Thermal
Webb, Robert W. . . . . Palm Desert
Westerfield, John . . . . Coachella
Wilson, Gwynn . . . . Los Angeles
Wise, George . . . . Mecca
Wolfe, A. F. . . . . New York
Woodbury, George J. . . . . Indio

Yost, Leland J. . . . . Thermal
Yowell, Hillman . . . . Indio

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